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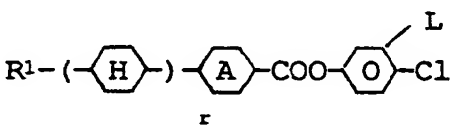
(54) **Supertwist liquid-.crystal display.**

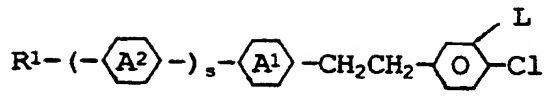
(57) The invention relates to supertwist liquid-crystal displays (SFAs) having extremely short switching times and good steepnesses and angle dependencies, and to the novel nematic liquid-crystal mixtures used therein based on



I

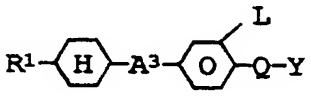
and/or one or more compounds of the formula II

EP 0 460 436 A2



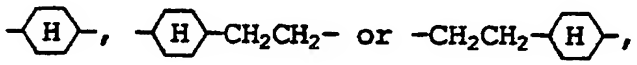
II

and/or one or more compounds of the formula III



III

wherein R^1 is alkyl having 1-12 C atoms, wherein one or two non-adjacent CH_2 groups can also be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O-, r is O or 1, s is O, 1 or 2, rings A^1 and A^2 are independently from each other trans-1,4-cyclohexylene, 1,4-phenylene or 3-fluoro-1,4-phenylene A^3 denotes



Q is OCFH, OCF_2, CF_2 or a single bond, Y is H, F or Cl, and L denotes H or F.

The invention relates to supertwist liquid-crystal displays (SFAs) having extremely short switching times and good steepnesses and angle dependencies, and to the novel nematic liquid-crystal mixtures used therein.

SFAs as in the heading are known, for example from EP 0,131,216 B1; DE 3,423,993 A1; EP 0,098,070 A2; M. Schadt and F. Leenhouts, 17th Freiburg conference on liquid crystals (8-10.04.87); K. Kawasaki et al., SID 87 Digest 391 (20.6); M. Schadt and F. Leenhouts, SID 87 Digest 372 (20.1); K. Katoh et al., Japanese Journal of Applied Physics, Vol. 26, No. 11, L 1784-L1786 (1987); F. Leenhouts et al., Appl. Phys. Lett. 50 (21), 1468 (1987); H.A. van Sprang and H.G. Koopman, J. Appl. Phys. 62 (5), 1734 (1987); T.J. Scheffer and J. Nehring, Appl. Phys. Lett. 45 (10), 1021 (1984), M. Schadt and F. Leenhouts, Appl. Phys. Lett. 50 (5), 236 (1987) and E.P. Raynes, Mol. Cryst. Liq. Cryst. Letters, Vol. 4 (1), pp. 1-8 (1986). The term SFA here includes any relatively highly twisted display element having a twist angle with a value between 160° and 720°, such as, for example, the display elements of Waters et al. (C.M. Waters et al., Proc. Soc. Inf. Disp. (New York) (1985) (3rd Intern. Display Conference, Kobe, Japan), the STN-LCDs (DE OS 3,503,259), SBE-LCDs (T.J. Scheffer and J. Nehring, Appl. Phys. Lett. 45 (1984) 1021), OMI-LCDs (M. Schadt and F. Leenhouts, Appl. Phys. Lett. 50 (1987), 236, DST-LCDs (EP OS 0,246,842) or BW-STN-LCDs (K. Kawasaki et al., SID 87 Digest 391 (20.6)).

Compared with standard TN displays, SFAs of this type are distinguished by significantly better steepnesses of the electrooptical characteristic and, associated therewith, better contrast values, and by a significantly lower angle dependence of the contrast. Of particular interest are SFAs with extremely short switching times, in particular also at relatively low temperatures. In order to achieve short switching times,the viscosities, in particular of the liquid crystal mixtures have hitherto been optimized using usually optimized combinations of liquid crystal components and optionally also monotropic additives of relatively high vapour pressure. However, the switching times achieved were not adequate for all applications.

Shorter switching times can also be achieved by reducing the thickness of LC layer of the SFA and using liquid-crystal mixtures with a higher birefringence Δn.

All these approaches to shorter switching times, however, still end up with mixtures which were not adequate for every use.

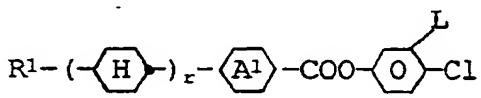
Further demands for SFA are a higher multiplexability (resulting in a smaller number of LC's), lower threshold voltages and a steep characteristic curve.

Optimal parameters, however, cannot be achieved simultaneously for all the properties mentioned above because of opposite influence of different material parameters such as dielectric and elastic properties.

Therefore, there continues to be a great demand for improved SFAs having short switching times and, at the same time, a broad service-temperature range, high characteristic line steepness, good angle dependency of the contrast and low threshold voltage.

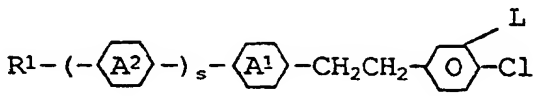
The invention has the object of providing SFAs which only have the abovementioned disadvantages to a small extent, or not at all, and at the same time have very useful overall properties.

It has now been found that this object can be achieved if nematic liquid-crystal mixtures are used which contain one or more compounds of the formula I



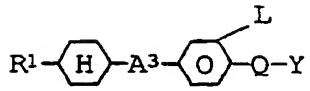
I

and/or one or more compounds of the formula II

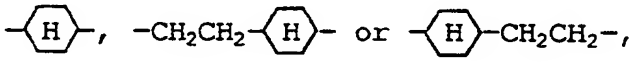


II

and/or one or more compounds of the formula III



wherein R^1 is alkyl having 1-12 C atoms, wherein one or two non-adjacent CH_2 groups can also be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O-, r is 0 or 1, s is 0, 1 or 2, rings A^1 and A^2 are independently from each other trans-1,4-cyclohexylene, 1,4-phenylene or 3-fluoro-1,4-phenylene A^3 denotes

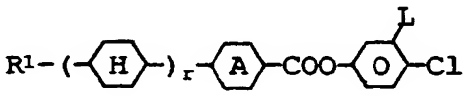


Q is OCHF, OCF_2, CF_2 or a single bond, Y is H, E or Cl and L denotes H or F.

The nematic liquid-crystal mixture preferably has a nematic phase range of at least 60 °C, a viscosity of not more than 30 mPa.s and a dielectric anisotropy of at least +5, the dielectric anisotropies of the compounds and the parameters related to the nematic liquid-crystal mixture being based on a temperature of 20 °C.

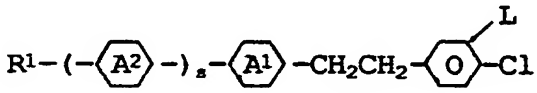
The invention thus relates to an SFA having

- two plane-parallel carrier plates which, with an edging, form a cell,
- a nematic liquid crystal mixture of positive dielectric anisotropy in the cell,
- electrode layers with superimposed orientation layers on the inside of the carrier plates,
- an angle of incidence between the longitudinal axis of the molecules on the surface of the carrier plates and the carrier plates of about 1 degree to 30 degrees and
- the absolute amount of the twisting angle of the liquid crystal mixture in the cell from orientation layer to orientation layer being between 160 and 720 °, characterized in that the nematic liquid crystal mixture contains one or more compounds of the formula I



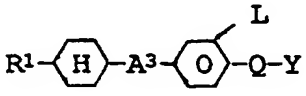
I

and/or one or more compounds of the formula II



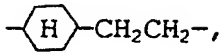
II

and/or one or more compounds of the formula III



III

wherein R^1 is alkyl having 1-12 C atoms, wherein one or two non-adjacent CH_2 groups can also be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O-, r is 0 or 1, s is 0, 1 or 2, rings A^1 and A^2 are independently from each other trans-1,4-cyclohexylene, 1,4-phenylene or 3-fluoro-1,4-phenylene, A^3 denotes - H -, $-CH_2CH_2-$ H - or



Q is OCHF, OCF_2, CF_2 or a single bond, Y is H, F or Cl, and L denotes H or F.

The invention also relates to corresponding liquid-crystal mixtures.

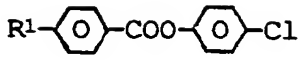
The individual compounds of the formulae I, II and III and also other compounds which can be used in the SFAs according to the invention, are either known or can be prepared analogously to the known compounds.

The mixtures of this invention allow the realization of SFAs with high multiplex ratios, broad working temperature range, low threshold voltages (below 3 volt, preferably between 1.25 and 2.80, in particular between 1.60 and 2.20 volt) and steep characteristic curves.

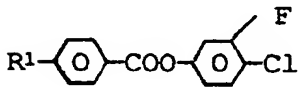
The compounds of the formulae I, II and III have low values of the ratio of the elastic constants (K_3/K_1) and lead therefore to short switching times.

The mixtures according to the present invention have an optic anisotropy (Δn) of more than 0.120, preferably 0.130-0.170, in particular 0.130-0.160.

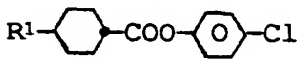
The mixtures according to the invention preferably contain one or more compounds selected from the following group:



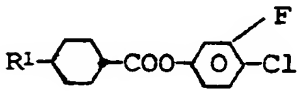
Ia



Ib



Ic



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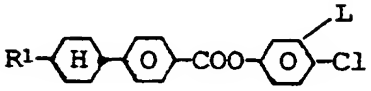
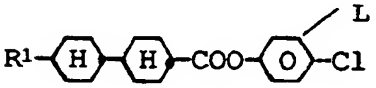


Ie



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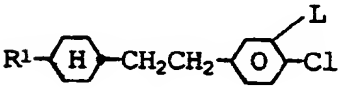
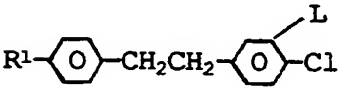


IIa



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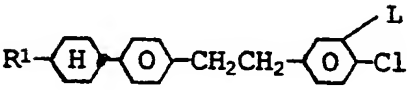

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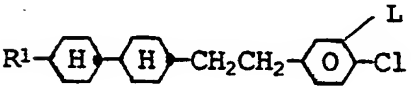

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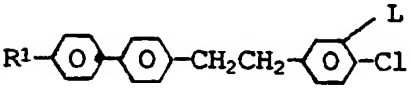

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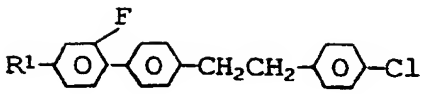

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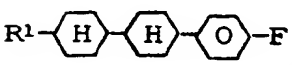

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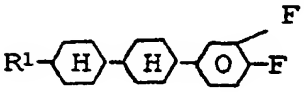

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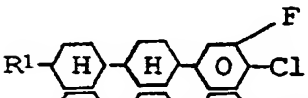

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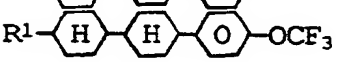

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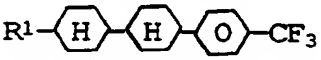

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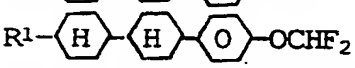

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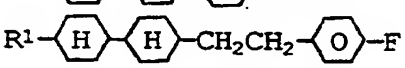

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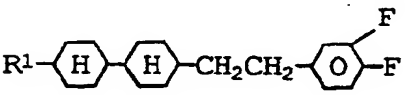

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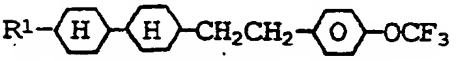

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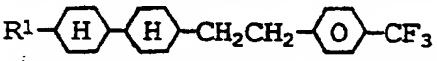

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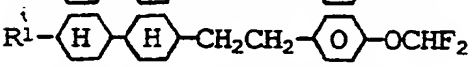

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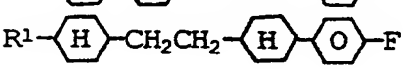

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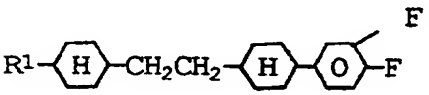

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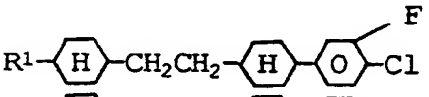

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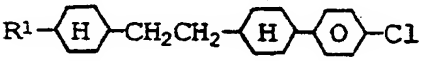

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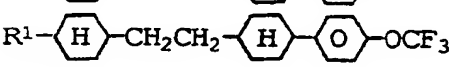
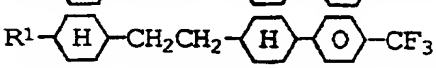
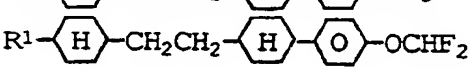


IIIp



IIIq

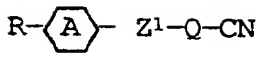


IIIr

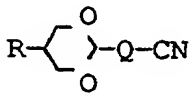
Preferred mixtures contain one, two, three or more compounds of the formulae If, IIId, IIIh, IIIi, IIII, IIIs, in particular one or more compounds of the formula IIId or IIIs and one or three compounds selected from the formulae If, IIIh, IIIi, IIII, IIIt and IIIu.

Preferred liquid-crystal mixtures which can be used according to the invention contain one or more compounds from group A preferably in a proportion of 5 % to 50 %, preferably 10 % to 40 %. These compounds or this compound from group A have a dielectric anisotropy of more than +8 (preferably of more than +12) and form the component A of the LC mixtures of this invention.

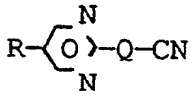
Preferably group A comprises compounds selected from the following group:



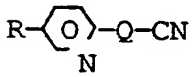
AI



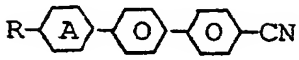
AII



AIII



AIV

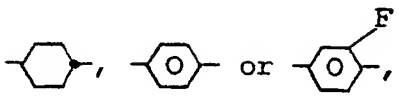


AV

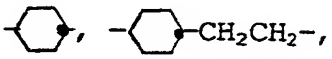
wherein

R is alkyl having 1-12 C atoms, wherein one or two non-adjacent CH_2 groups can also be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O-,

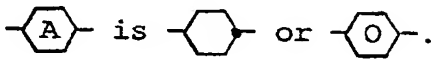
Q is the formula



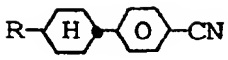
Z^1 is



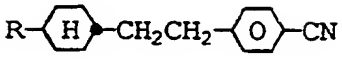
a single bond, $-CH_2CH_2-$, -CO-O- or -O-CO- and



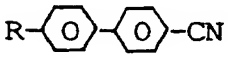
Preferably the mixtures comprise one ore more compounds of the formula AI in the range of 5 to 50 %. Preferred are those compounds wherein Z^1 denotes a single bond, $-CH_2CH_2-$ or -CO-O- and especially preferred are the following compounds:



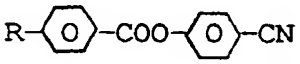
AI1



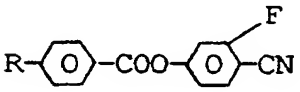
AI2



AI3

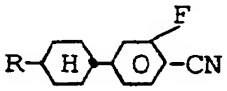


AI4



AI5

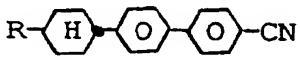
Also preferred are the following compounds:



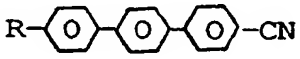
AI6

Group A preferably comprises one ore more compounds selected from the formulae AI1 to AI5 and optionally also one or more compounds of the formula AI6.

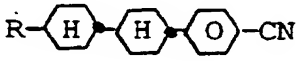
Preferably the mixtures further contain one or more polar compounds with a higher clearing point, e.g. selected from the following compounds:



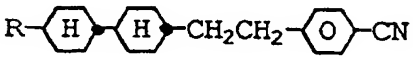
AV1



AV2

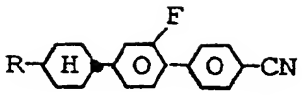


AI5

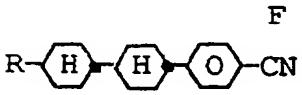


AI6

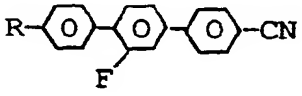
In the above four formulae the 1,4-phenylene rings can also be laterally substituted by one fluorine atom, e.g.



AV1a



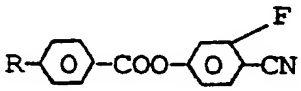
AI5a



AV2a

These polar compounds with a higher clearing point are preferably used in the range of 2 to 15 %.

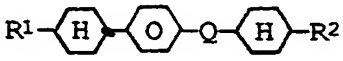
In another preferred embodiment the mixtures comprise one or more compounds with a very high dielectric anisotropy. Such compounds are preferably used in the range of 2 to 50 %. Preferred compounds of this type are those of the formulae AII, AIII and AV, wherein Q denotes 1,4-phenylene or 3-fluoro-1,4-phenylene or compounds of the formula AI7:



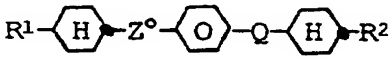
AI7

Preferred liquid-crystal mixtures contain one or more compounds from group B, preferably in a proportion of 10 % to 40 %. These compounds or this compound from group B have a clearing point of more than 120 ° and dielectrically neutral ($(\Delta\epsilon) < 2$) or medium polar ($\Delta\epsilon$ in the range of +2 to +10, preferably +4 to +8) and form component B of the LC mixtures of this invention.

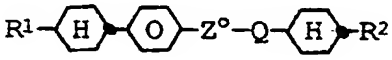
Preferably group B comprises compounds selected from the following group:



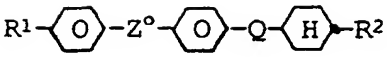
BI



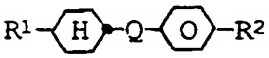
BII



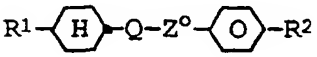
BIII



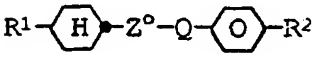
BIV



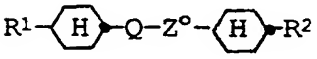
BV



BVI



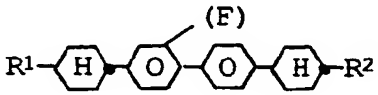
BVII



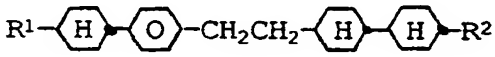
BVIII

wherein R^1 and R^2 each independently of one another are R as defined in claim 3, Z° is -CO-O-, -O-CO- or $-CH_2CH_2-$, Q is as defined in claim 3 and the 1,4-phenylene ring in BI to BVII may also be substituted in 2- or 3-position by fluorine.

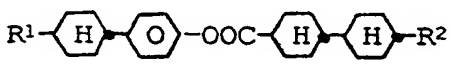
Preferably the mixtures comprise one or more compounds with four rings of the formulae BI to BIV in order to achieve a high clearing point. These compounds are preferably selected from the group of the following four-ring compounds:



BI1

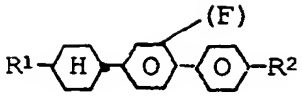


BIII1



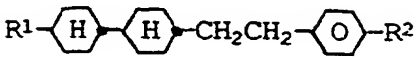
BIII2

Preferably the mixtures comprise also one or more compounds selected from the following group of three-ring compounds:

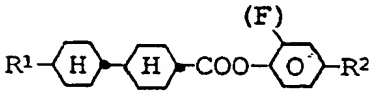


BV1

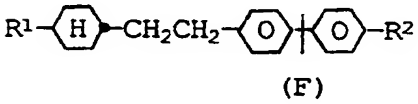
BV2



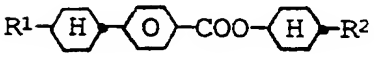
BVI1



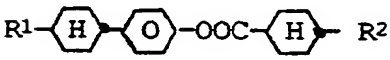
BVI2



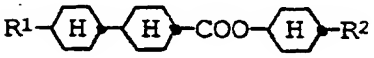
BVII1



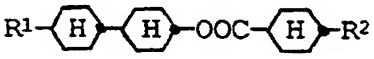
BVIII1



BVIII2

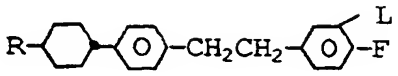


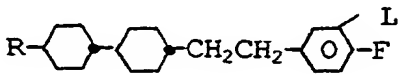
BVIII3

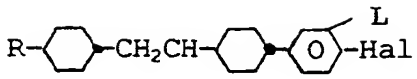


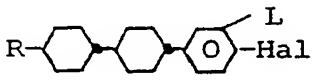
BVIII4

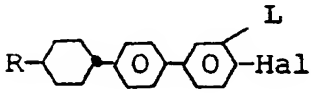
In another preferred embodiment the LC mixtures also contain one or more compounds from the following group:







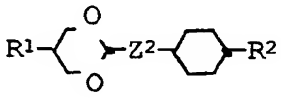




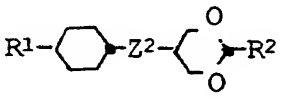
wherein Hal is F or Cl and L and R are as defined above.

The LC mixtures also comprise an optically active component C, in an amount such that the ratio between the layer thickness (separation of the plane-parallel carrier plates) and the natural pitch of the chiral nematic liquid crystal mixture is more than 0.2 suitable to the desired twist angle. Suitable dopants can be selected from a wide variety of known chiral materials and commercially available dopants such as cholesteryl nonanoate, S 811 (E. Merck, Darmstadt, FRG) and CB 15 (BDH, Poole, UK). The choice thereof is not crucial per se.

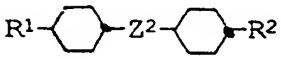
Preferably the mixtures also contain one or more compounds from group B1 comprising the compounds of the formulae B1I to B1IV:



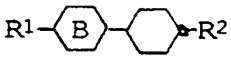
B1I



B1II

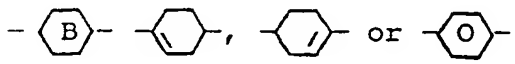


B1III

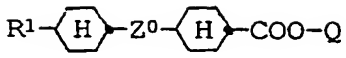


B1IV

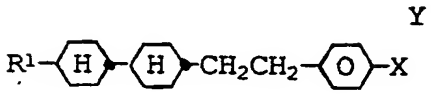
in which R^1 and R^2, in each case independently of one another, are as defined for R, Z^2 is $-CH_2CH_2-$, -CO-O-, -O-CO-or a single bond, and



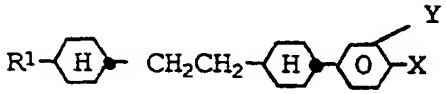
and/or at least one component selected from group B2 comprising the compounds of the formulae B1V to B1VII:



B1V

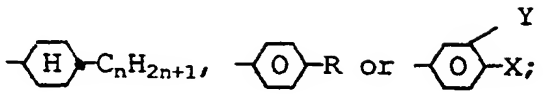


B1VI

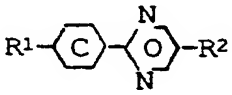


B1VII

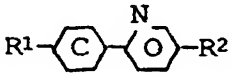
in which R^1 is as defined for R,
Z^0 is $-CH_2CH_2-$ or a single bond, and
Q is



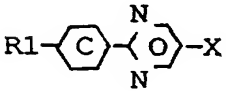
where n is 1 to 9, X is CN or F and Y is H or F; and/or at least one component selected from group B3 comprising the compounds of the formulae BVIII, BIX and BX:



BVIII



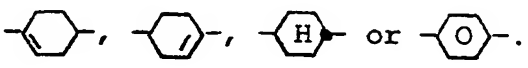
BIX



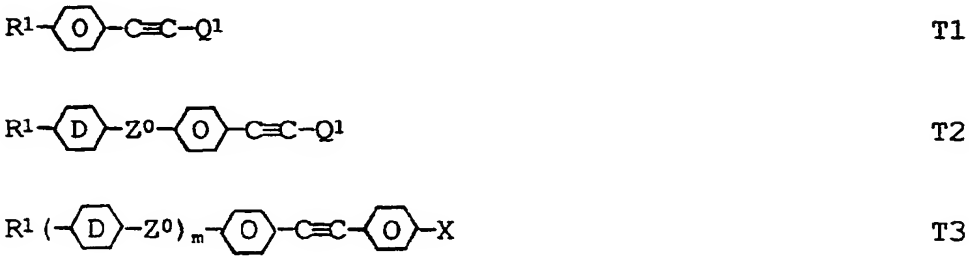
BX

in which R^1 and R^2, in each case independently of one another, are as defined for R, X is Cl or F, and

is



In a further preferred embodiment the LC mixtures contain one or more compounds selected from group T, comprising compounds of the formulae TI and T2:

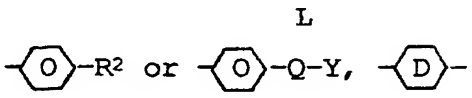


T1

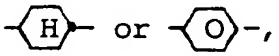
T2

T3

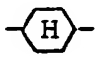
in which Q^1 is



is



preferably



L, Y and Q are as defined for the compounds of the formula III

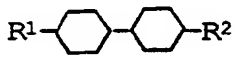
R^1 and R^2, in each case independently of one another, are each R,

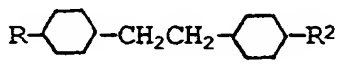
R is alkyl having 1-12 C atoms, in which, in addition, one or two non-adjacent CH_2 groups may be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O-, and Z^0 is $-CH_2CH_2-$ or a single bond, and the 1,4-phenylene rings may also be laterally substituted by fluorine,

X is F, Cl or OCF_3, and m is 0 or 1.

The proportion of component(s) from group T is preferably 5 % to 30 %, in particular 5 % to 20 %.

The proportion of component(s) from group B1 is preferably 5 % to 45 %, in particular preferably about 10 % to 40 %. Components of the formulae B1III and B1IV are preferred. Particularly preferred compounds of the formula B1III are those of the following sub-formulae:





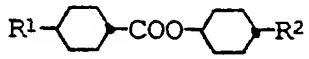
in which

R^1 is $CH_3-(CH_2)_n-O-$, $-CH_3-(CH_2)_t-$, trans-$H-(CH_2)_r-CH=CH-(CH_2CH_2)_s-CH_2O-$ or trans-$H-(CH_2)_r-CH=CH-(CH_2CH_2)_s-$,

R^2 is $CH_3-(CH_2)_t-$,

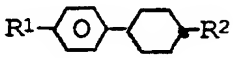
n is 1, 2, 3 or 4,
r is 0, 1, 2 or 3,
s is 0 or 1, and
t is 1, 2, 3 or 4.

Furthermore preferred compounds are those of the sub-formula



in which R^1 and R^2 are as defined above.

The proportion of the compounds of the formula B1III of the abovementioned sub-formulae is preferably about 5 % to 45 %, in particular preferably about 10 % to 35 %. Particularly preferred compounds of the formula B1IV are those of the following sub-formula:

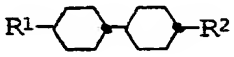


in which

R^1 is CH_3-$(CH_2)_n$-O- or trans-H-$(CH_2)_r$-CH=CH-$(CH_2CH_2)_s$-CH_2O- and R^2 is CH_3-$(CH_2)_t$-, where
n is 1, 2, 3 or 4,
r is 0, 1, 2 or 3,
s is 0 or 1, and
t is 1, 2, 3 or 4.

The proportion of these compounds or of the compounds of the formula B1IV is preferably about 5 % to 40 %, in particular preferably about 10 % to 35 %.

The mixtures preferably contain compounds of the formula III, in particular those of the sub-formula

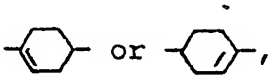


In a particularly preferred embodiment, the mixtures simultaneously contain compounds of the formulae B1III and B1IV, the total proportion for components of group B1 being observed.

If compounds of the formulae B1I and B1III are present, R^1 and R^2 are preferably, in each case independently of one another, n-alkyl having 1 to 7 C atoms or (trans)-n-alkenyl having 3 to 7 C atoms. Z^2 is preferably a single bond. BI is particularly preferred.

Furthermore preferred mixtures according to the invention are those which contain one or more compounds of the formula B1IV in which

is



and R^1 and R^2 have one of the abovementioned preferred meanings, in particular preferably n-alkyl having 1 to 7 C atoms.

In all cases, the total proportion for components of group B1 is observed.

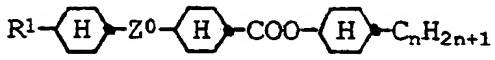
The proportion of the compounds of group B2 is preferably about 5 % to 45 %, in particular preferably

5 % to 20 %. The proportion (preferred ranges) for B1V to B1VII is as follows:

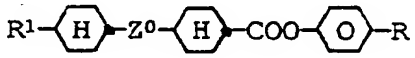
B1V about 5 % to 30 %, preferably about 5 % to 15 %

Total of B1VI and B1VII: about 5 % to 25 %, preferably about 10 % to 20 %.

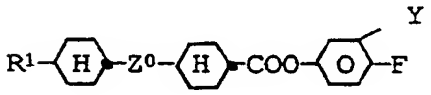
Preferred compounds of group B2 are indicated below:



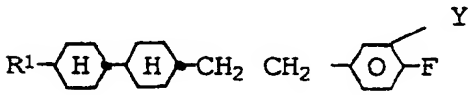
B1VI



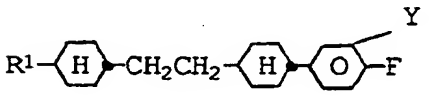
B1V2



B1V3



B1VI1

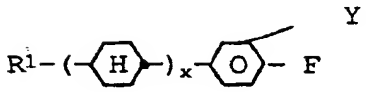


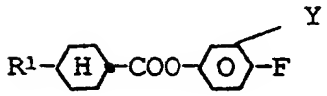
B1VII1

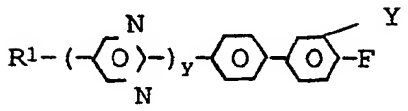
R^1 is preferably n-alkyl having 1 to 7 C atoms or (trans)-n-alkenyl having 3 to 7 C atoms. Z^0 is preferably a single bond. R preferably has the preferred meaning mentioned above for R^1 or is fluorine. Y is preferably fluorine.

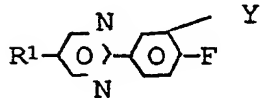
The mixtures according to the invention preferably contain one or more compounds selected from the group comprising B1V3, B1VI1 and B1VII1 in a total proportion of about 5 to 35 %.

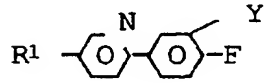
In a particularly preferred embodiment, the mixtures according to the invention contain, besides B1V3, B1VI1, B1VII1 and B1V2 (R = F), further terminally fluorinated compounds, for example selected from the group comprising:

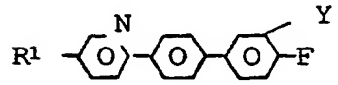












in which R^1 is preferably n-alkyl having 1 to 7 C atoms or (trans)-n-alkenyl having 3 to 7 C atoms, X is 1 or 2, y is 0 or 1 and Y is H or F.

The total proportion of all terminally fluorinated compounds is preferably about 5 % to 65 %, in particular about 15 % to 40 %.

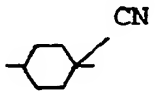
The proportion of the compounds from group B3 is preferably about 5 % to 30 %, in particular preferably about 10 % to 20 %. R^1 is preferably n-alkyl or n-alkoxy, each having 1 to 9 C atoms. However, it is also possible to employ analogous compounds containing alkenyl or alkenyloxy groups. Compounds of the formula BVIII are preferred.

is preferably 1,4-phenylene.

The mixtures according to the invention contain compounds from at least one of groups B1, B2 and B3. They preferably contain one or more compounds from B1 and one or more compounds from group B2 and/or B3.

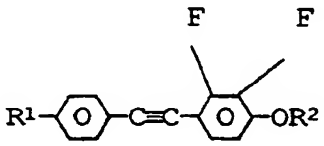
The proportion of compounds of component C is preferably about 5 % to 60 %, in particular about 20 % to 50 %. Those skilled in the art can easily adjust this proportion to produce the threshold voltage desired, it being possible to use, in principle, all customary liquid-crystal compounds where $\Delta\epsilon > +2$. If predominantly less-positive terminally fluorinated compounds are used, the total proportion can be above the upper range (about 35 % to 80 %), while the proportion may be lower (about 10 % to 35 %) if terminally cyano-substituted compounds are used.

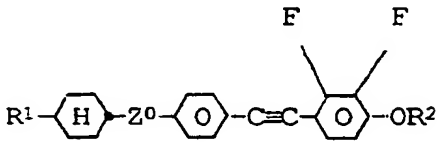
In a particularly preferred embodiment, the mixtures according to the invention preferably contain about 5 % to 20 % of one or more compounds having a dielectric anisotropy of less than -2 (component D). Compounds of this type are known, for example derivatives of 2,3-dicyanohydroquinone or cyclohexane derivatives containing the structural element



as in DE-OS 3,231,707 or DE-OS 3,407,013.

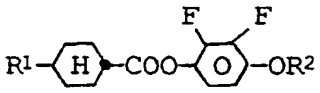
However, compounds containing the structural element 2,3-difluoro-1,4-phenyleneare preferably chosen, for example compounds as in DE-OS 3,807,801, 3,807,861, 3,807,863, 3,807,864 or 3,807,908. Particularly preferred are tolans containing these structural elements, as in International Patent Application PCE/DE 88/00133, in particular those of the formulae

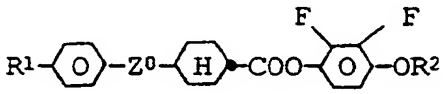




in which R^1 and R^2 , in each case independently of one another, are preferably n-alkyl having 1 to 7 C atoms or n-alkenyl having 3 to 7 C atoms, and Z^0 is $-CH_2CH_2-$ or a single bond.

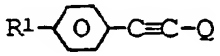
Particularly preferred are also the phenylcyclohexylcarboxylates of the formulae

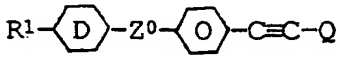




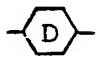
Component D causes, in particular, an improvement in the steepness of the characteristic line.

In a particularly preferred embodiment, the mixtures contain about 5 % to 35 %, in particular preferably about 10 % to 20 %, of liquid-crystalline tolan compounds. These make it possible to work with smaller cell thicknesses (about 5-6 μm), which significantly shorten the switching times. Particularly preferred tolans are indicated below:

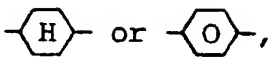




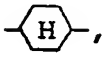
R^1 is preferably n-alkyl having 1 to 7 C atoms,
Z^0 is $-CH_2CH_2-$ or a single bond,



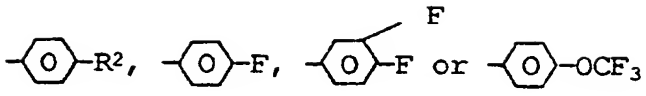
is



preferably



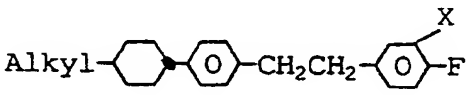
Q is

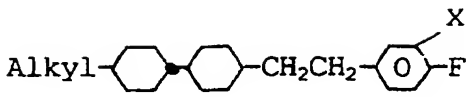


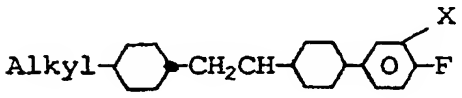
where
R^2 is n-alkyl or n-alkoxy, each having 1 to 7 C atoms, or n-alkenyl or n-alkenyloxy, each having 3 to 7 C atoms.

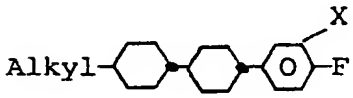
In further particularly preferred embodiments, the mixtures contain

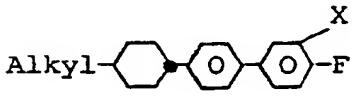
- a component D which contains one or more compounds having a 1-cyano-trans-1,4-cyclohexylene group or a 2,3-difluoro-1,4-phenylene group,
- at least two compounds of the formulae AIII or AV,
- compounds of the formulae AIII and AV,
- at least one compound from the following group:

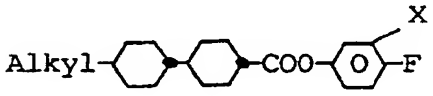






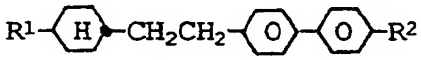


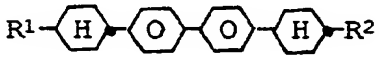




in which alkyl is a straight-chain alkyl group having 2-7 C atoms, and X is H or F,

- one or more compounds in which R is a trans-alkenyl group or a trans-alkenyloxy group,
- one or more compounds selected from the following group

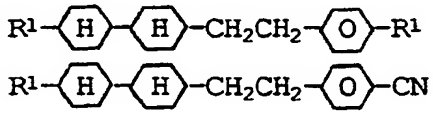




in which R^1 and R^2 have the preferred meanings indicated in the case of component B, and one of the two 1,4-phenylene groups may also be substituted by fluorine; the proportion of these compounds is 0 % to 25 %, preferably about 5 % to 15 %.

In a further particularly preferred embodiment the mixtures contain

- one or more, in particular 1, 2, 3 or 4, compounds selected from the formulae IIId, IIIb, IIIi and IIIp
- at least two compounds selected from the formulae AI1, AI3, AI4 or AI5
- one or more compounds of the formula B1IV
- one or more compounds of the formulae T1 or T2 or
- one or more compounds selected from the following group



wherin R1 is defined as for the compounds of the formula III.

The construction of the liquid-crystal display elements according to the invention from polarizers, electrode base plates and electrodes having a surface treatment such that the preferential orientation (director) of the liquid-crystal molecules in each case adjacent thereto is usually mutually twisted from one electrode to the other by a value of 160° to 720°, corresponds to the customary construction for display elements of this type. The term customary construction here is used in broad terms and also includes all derivatives and modifications of supertwist cells, in particular also matrix display elements. The surface tilt angle at the two support plates may be identical or different. Identical tilt angles are preferred.

An essential difference between the display elements accordding to the invention and the display elements customary hitherto based on the twisted nematic cell is, however, the choice of liquid-crystal components in the liquid-crystal layer.

The liquid-crystal mixtures which can be used according to the invention are prepared in a manner customary per se. In general, the desired amount of the components used in a relatively small amount is dissolved in the components making up the principal constituent, expediently at elevated temperature. It is also possible to mix solutions of the components in an organic solvent, for example in acetone, chloroform or methanol, and to remove the solvent again, after mixing, for example by distillation.

The dielectrics may also contain further additives known to those skilled in the art and described in the literature. For example, 0-15 % of pleochroic dyes may be added.

The examples below are intended to illustrate the invention, without representing a limitation.

The abbreviations have the following meanings:

S-N	smectic-nematic phase transition temperature,
N-I	nematic-isotrop phase transition temperature,
c.p.	clear point,
visc.	viscosity (m Pa.s),
T_{on}	time from switching on until 90 % of the maximum contrast is reached,
T_{off}	time from switching off until 10 % of the maximum contrast is reached,
V_{10}	threshold voltage (volt).

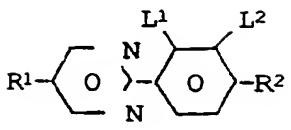
The SFA is addressed in multiplex operation (multiplex ratio 1:100, bias 1:11, operating voltage 18.5 volts).

Above and below, all temperatures are given in °C. Percentages are per cent by weight. The values for the switching times and viscosities relate to 20 °C.

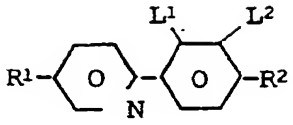
In the present patent application and in the following examples all chemical structures of LC compounds are given by acronyms the transformation of which into chemical formulae is done as shown in the following. All residues C_nH_{2n+1} and C_mH_{2m+1} are straight-chained alkyl groups with n resp. m carbon atoms. The code of Table B is self-explanatory. In Table A only the acronym for the core structure is given. In a concrete compound this acronym is followed by a dash and a code for the substituents R^1, R^2, L^1 and L^2 as follows:

Code for R^1, R^2, L^1, L^2	R^1	R^2	L^1	L^2
nm	C_nH_{2n+1}	C_mH_{2m+1}	H	H
nOm	C_nH_{2n+1}	OC_mH_{2m+1}	H	H
nO.m	OC_nH_{2n+1}	C_mH_{2m+1}	H	H
n	C_nH_{2n+1}	CN	H	H
nN.F	C_nH_{2n+1}	CN	H	F
nF	C_nH_{2n+1}	F	H	H
nOF	OC_nH_{2n+1}	F	H	H
nCl	C_nH_{2n+1}	Cl	H	H
nF.F	C_nH_{2n+1}	F	H	F
nOmFF	C_nH_{2n+1}	OC_mH_{2m+1}	F	F
nmF	C_nH_{2n+1}	C_mH_{2m+1}	F	H
nCF_3	C_nH_{2n+1}	CF_3	H	H
$nOCF_3$	C_nH_{2n+1}	OCF_3	H	H
$nOCF_2$	C_nH_{2n+1}	$OCHF_2$	H	H
nS	C_nH_{2n+1}	NCS	H	H
rVsN	$C_rH_{2r+1}-CH=CH-C_sH_{2s}-$	CN	H	H
rEsN	$C_rH_{2r+1}-O-C_sH_{2s}-$	CN	H	H
nNF	C_nH_{2n+1}	CN	F	H
nAm	C_nH_{2n+1}	$COOC_mH_{2m+1}$	H	H
nF.Cl	C_nH_{2n+1}	Cl	H	F

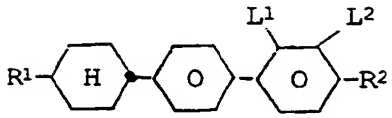
Table A:



PYP



PYRP



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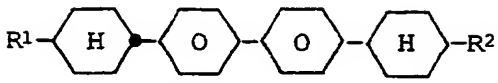
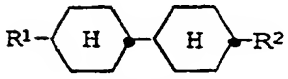
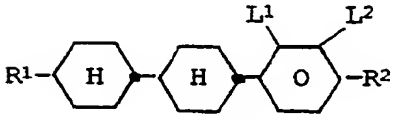


CBC



CCH



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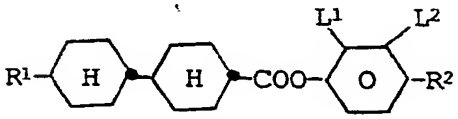
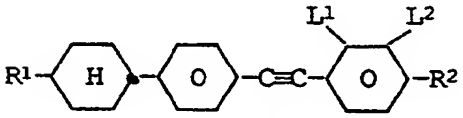
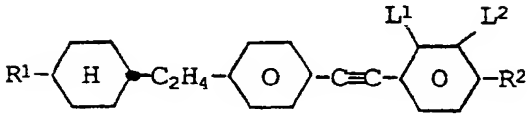


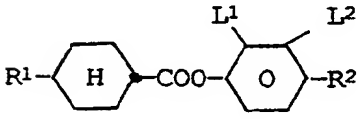
CP



CPTP



CEPTP



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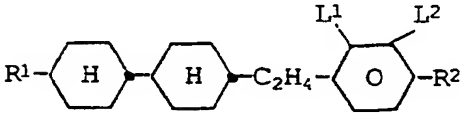

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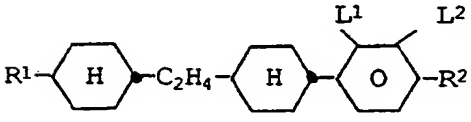

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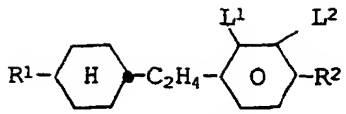
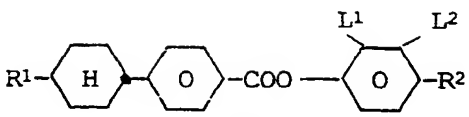


EPCH



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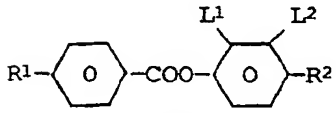
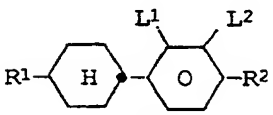


ME



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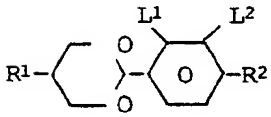

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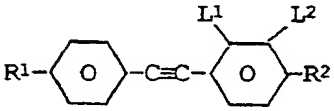

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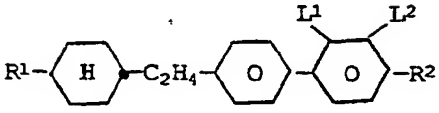

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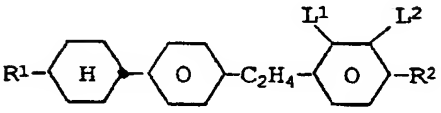
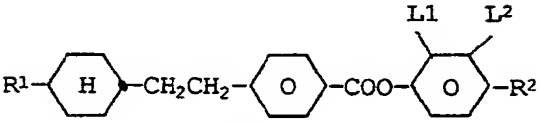


EBCH

CPC



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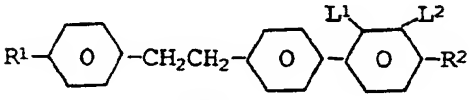

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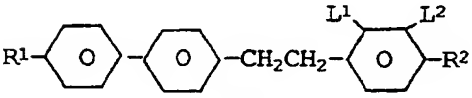

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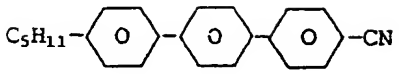

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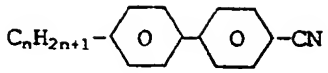
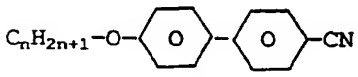


K3n



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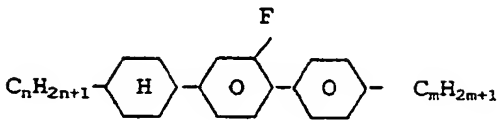

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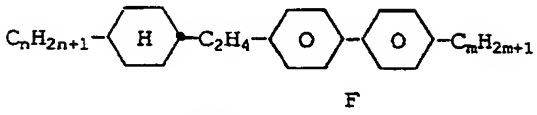
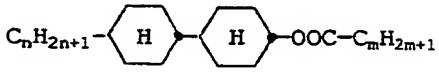
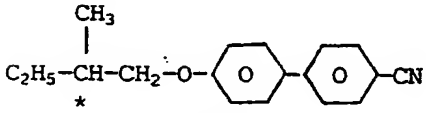


Inm



C-nm



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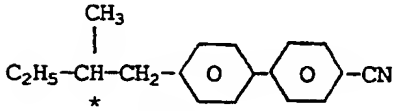

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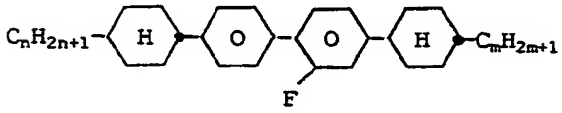
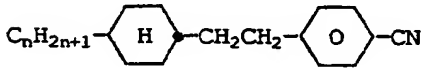
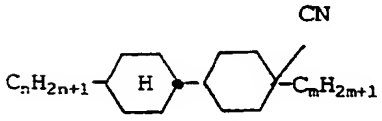


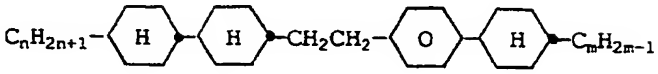
CBC-nmF



G3n



CCN-nm



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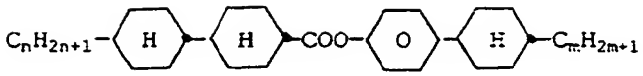

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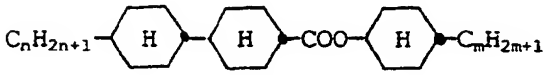
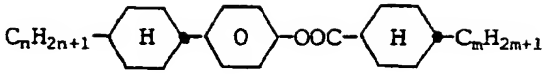
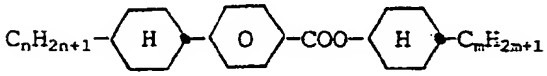


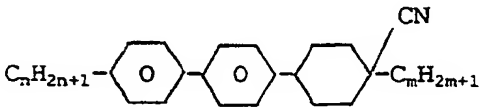
CH-nm



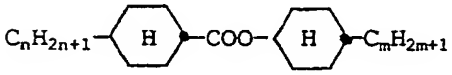
HD-nm



HH-nm



NCB-nm



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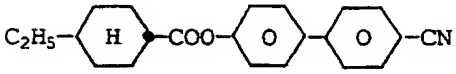

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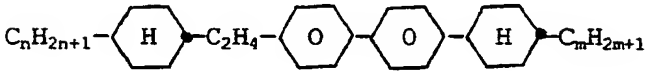
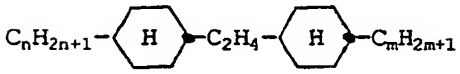


ECBC-nm



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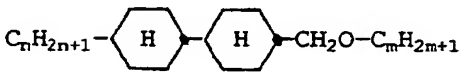

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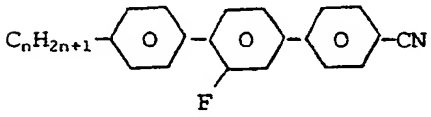


T-nFN

Cl_{eu} is a mixture consisting of
23.5 % of D-3Cl,
26.3 % of D-5Cl,
27.0 % of CP-3Cl and
23.2 % of CP-5Cl.

$Cl.F_{eu}$ is a mixture consisting of
22.50 % of D-3Cl.F
22.50 % of D-5Cl.F

30.25 % of CP-3Cl.F
24.75 % of CP-5Cl.F

I_{eu} is a mixture consisting of
33.3 % of I32
33.3 % of I52
33.3 % of I35

The following liquid-crystal mixtures show advantageous properties in SFA.

Example 1

A mixture A consisting of

	%
G9	19.8
PDX-2	5.97
PDX-3	11.87
PDX-4	8.42
ME-2NF	7.42
ME-3NF	8.45
CCH-303	7.92
CP-55F	12.94
CBC-33F	4.9
CBC-53F	5.45
CBC-55F	4.95
CBC-33	4.91

exhibits the parameters shown in the following table. Replacing the component CP-55F by the same percentage of CP-3Cl results in the mixture B of this invention, the parameters of which are also shown in the following table:

	Mixture A	Mixture B
N-I	97.9°	98.8°
η^{20}	36.7 cSt	34.7 cSt
Δn	0.126	0.129
$\Delta\varepsilon$	15.7	16.5
$\varepsilon_\perp$	6.5	6.5
$\varepsilon_\parallel$	22.2	23.0
$\varepsilon\ \Delta/\varepsilon_\perp$	2.4	2.5

Examples 2 and 3

A standard STN mixture C consisting of

I_{eu}	46.99
K6	13.99
K9	10.03
K15	13.98
CBC33F	5.0
CBC53F	5.0
T15	5.0

exhibits the parameters shown in the following table. Replacing the component I_{eu} by the same percentage of $Cl.F_{eu}$ (ex. 2) or Cl_{eu} (ex. 3) results in the mixtures of examples 2 and 3 of this invention, the parameters of which are also shown in the following table:

	Mixture C	Example 2	Example 3
N-I (°C)	95.8	83.4	97.5
Δn	0.195	0.169	0.177
$\Delta\varepsilon$	9.24	13.58	10.67
$\varepsilon_\perp$	4.06	6.39	4.81
$\Delta\varepsilon/\varepsilon_\perp$	2.27	2.12	2.18
visc. (cSt)	35.8	29.8	27.2

Examples 4 a) and 4 b)

The composition and data for further mixtures are as follows:

	Example 4 a)		Example 4 b)	
N-I (°C)	91		89	
Δn	0.13		0.133	
$\Delta\varepsilon$	6.54		6.48	
$\Delta\varepsilon/\varepsilon_\perp$	1.48		1.25	
visc. (cSt)	21.7		23.4	
Composition				
	$Cl.F_{eu}$	37	$Cl.F_{eu}$	35
	K6	8	K6	8
	K9	5	K9	5
	PCH302	13	PCH302	12
	CCEPC 33	9	CCEPC 33	8
	CCEPC 35	9	CCEPC 35	8
	BEP 3CL.F	6	BEP 3CL.F	8
	BEP 5CL.F	7	BEP 5CL.F	7
	D 31F	6	D 302FF	9

Examples 5 a), b) and c)

The composition and data for further mixtures are as follows:

	Example 5 a)	Example 5 b)	Example 5 c)
N-I (°C)	99	91.4	83
Δn	0.137	0.1337	0.1207
Δε	9.9	8.66	14.33
visc. (cSt)	27.3	23.9	30.24
ECCP 3Cl.F	11.95	ECCP 3Cl.F 9.75	ECCP 3Cl.F 9.0
ECCP 3Cl	11.98	ECCP 3Cl 9.77	ECCP 3Cl 9.0
CPEP 3Cl	11.98	CPEP 3Cl 11.66	CPEP 5Cl 4.52
CPEP 5Cl	15.09	CPEP 5Cl 11.70	PDX 3 7.19
G9	8.0	ECCP 3H.F 9.8	PDX 4 10.77
K6	8.1	K6 9.89	PDX 5 9.92
CCPC 33	7.9	CCPC 33 7.89	G9 11.7
PCH 3	10.0		ME2NF 3.62
			ME3NF 4.48
			ME5NF 4.48
			CCH303 9.08
			CCPC33 6.27
			CCEPC33 4.98
			CCEPC55 4.99

Example 6

K6	7.0	
PCH-3	28.0	N - I (°C) + 83
PCH-4	8.0	
PCH-5	13.0	Δn 0,1412
PCH-301	4.0	Visc (cSt) 19
CCP-2 OCF3	8.0	V_{10} 1.77
CCP-3 OCF3	8.0	
CCP-4 OCF3	5.0	
CCP-5 OCF3	6.0	

CPTP-301	5.0	
CPTP-301	4.0	
CPTP-301	4.0	
Example 7		
ME2N.F	2.0	
ME3N.F	2.0	N - I (°C) + 94
PCH-3	18.0	Δn + 0.1174
PCH-5	11.0	
PCH-7	10.0	Visc (cSt) 20
PCH-301	5.0	V_{10} 2.07
CPTP-303	5.0	
CCP-20CF3	9.0	
CCP-30CF3	10.0	
CCP-50CF3	9.0	
ECCP-32	5.0	
ECCP-33	5.0	
ECCP-31	5.0	
ECCP-3	4.0	

Example 8

PCH-3	18.0	S < -20 N 94 I
PCH-5	11.0	V_{10} 2.07 volt
PCH-7	10.0	Δn 0.1174
ME2N.F	2.0	
ME3N.F	2.0	
CPTP-303	5.0	
CCP-2OCF3	9.0	
CCP-3OCF3	10.0	
CCP-5OCF3	9.0	
ECCP-32	5.0	
ECCP33	5.0	
ECCP31	5.0	
ECCP3	4.0	

Example 9

K6	7.0	S < -40 N 83 I
CCP-2OCF3	8.0	Δn 0.1412
CCP-3OCF3	8.0	
CCP-4OCF3	5.0	
CCP-5OCF3	6.0	
PCH-3	28.0	
PCH-4	8.0	
PCH-5	13.0	
PCH-301	4.0	
CPTP-301	5.0	
CPTP-302	4.0	
CPTP-303	4.0	

	Example 10		Example 11	
N-I	+ 92°		+ 90 °	
Δn	+0.1451		+0.1301	
V_{10}	2.52		1.94	
	PCH-6F	8.00	PCH-2	9.00
	CCP-3OCF3	10.00	PCH-3	22.00
	CCP-4OCF3	9.00	PCH-5	12.00
	CCP-5OCF3	9.00	PCH-301	13.00
	BCH-3F.F	13.00	CCP-3OCF3	7.00
	BCH-5F.F	12.00	CCP-5OCF3	7.00
	BEP-3F.CL	13.00	ECCP-33	6.00
	BEP-5F.Cl	13.00	ECCP-3F	6.00
	BCH-52F	13.00	ECCP-3	5.00
			CPTP-301	4.00
			CPTP-302	4.00
			CPTP-303	5.00

	Example 12		Example 13	
N-I	+ 78°		+ 93 °	
Δn	+0.1263		+0.1340	
V_{10}	2.11		1.93	
	G9	11.00	K6	6.00
	PCH-3	24.00	PCH-2	3.00
	PCH-5	5.00	PCH-3	22.00
	PCH-301	15.00	PCH-5	11.00
	CCP-3OCF3	5.00	PCH-301	6.00
	ECCP-3	5.00	CCP-2OCF3	7.00
	ECCP-31	5.00	CCP-3OCF3	7.00
	ECCP-32	5.00	CCP-4OCF3	7.00
	ECCP-33	4.00	CCP-5OCF3	7.00
	ECCP-35	4.00	ECCP-3OCF3	6.00
	PTP-201	6.00	ECCP-5OCF3	6.00
	BCH-32	5.00	CPTP-301	4.00
	BCH-52	6.00	CPTP-302	4.00
			CPTP-303	4.00

	Example 14		Example 15	
N-I	+ 76°		+ 87 °	
Δn	+0.1374		+0.1683	
V_{10}	2.02		1.86	
	G9	10.00	PCH-3	20.00
	PCH-3	24.00	K6	7.00
	PCH-5	5.00	K9	8.00
	CCH-301	10.00	BCH-5	3.00
	PCH-301	5.00	PCH-301	6.00
	ECCP-3	3.00	PTP-102	8.00
	CCP-3OCF3	5.00	PTP-201	8.00
	ECCP-3	5.00	CCP-3OCF3	14.00
	ECCP-31	5.00	CCP-5OCF3	12.00
	ECCP-32	5.00	ECCP-3F	6.00
	ECCP-33	4.00	BCH-52F	14.00
	PTP-102	7.00		
	PTP-201	7.00		
	BCH-32	5.00		
	BCH-52	5.00		

	Example 16		Example 17	
N-I	+ 70°		+ 86 °	
Δn	+0.1619		+0.1082	
V_{10}	1.76		1.32	
	PCH-3	20.00	PCH-5F	6.00
	K6	9.00	PCH-3	12.00
	K9	7.00	ME2N.F	2.00
	ME15	9.00	ME3N.F	3.00
	PTP-102	8.00	ME5N.F	4.00
	PTP-201	8.00	ME7N.F	5.00
	CCP-3OCF3	13.00	CCP-2OCF3	7.00
	CCP-5OCF3	12.00	CCP-3OCF3	7.00
	ECCP-3F	4.00	CCP-4OCF3	6.00
	BCH-52F	8.00	CCP-5OCF3	7.00
			ECCP-3OCF3	4.00
			ECCP-5OCF3	4.00
			ECCP-3F.F	6.00
			ECCP-5F.F	5.00
			ECCP-3	8.00
			D-301	4.00
			D-302	4.00
			D-401	4.00
			PTP-201	2.00

	Example 18		Example 19	
N-I	+ 77°		+ 75 °	
Δn	+0.1265		+0.1274	
V_{10}	2.28		2.01	
	G9	11.00	PCH-3	10.00
	K6	10.00	PCH-4	7.00
	PCH-3	19.00	K6	9.00
	PCH-301	18.00	K9	9.00
	CCP-3OCF3	5.00	PCH-301	5.00
	ECCP-3	5.00	CCP-3OCF3	14.00
	ECCP-31	5.00	CCP-5OCF3	10.00
	ECCP-32	5.00	ECCP-3F	14.00
	ECCP-33	5.00	ECCP-32	5.00
	ECCP-35	5.00		
	BCH-32	6.00		
	BCH-52	6.00		

	Example 20		Example 21	
N-I	+ 90°		+ 81 °	
Δn	-		+0.1320	
V_{10}	1.96		1.86	
	PCH-5F	6.00	K6	3.00
	PCH-6F	3.60	PCH-2	4.00
	PCH-7F	9.60	PCH-3	28.00
	CCP-2OCF3	8.20	PCH-5	13.00
	CCP-3OCF3	10.20	PCH-302	12.00
	CCP-5OCF3	11.00	CCP-2OCF3	8.00
	ECCP-3OCF3	8.30	CCP-3OCF3	8.00
	BCH-3F.F	9.50	CCP-4OCF3	6.00
	BCH-5F.F	10.30	CCP-5OCF3	6.00
	CP-5CL.F	11.80	CPTP-301	4.00
	CP-5CL.F	11.80	CPTP-302	4.00
			CPTP-303	4.00

	Example 22		Example 23	
N-I	+ 73°		+ 73 °	
Δn	+0.1712		+0.1694	
V_{10}	1.72		2.02	
	PCH-3	23.00	K6	8.00
	K6	9.00	K9	8.00
	K9	7.00	K15	4.00
	PTP-4OF	7.00	PCH-3	4.00
	PTP-102	8.00	PCH-53	4.00
	PTP-201	8.00	PCH-302	10.00
	CCP-3OCF3	13.00	PTP-4OF	8.00
	CCP-5OCF3	12.00	PTP-102	8.00
	ECCP-3F	4.00	PTP-201	8.00
	BCH-52F	9.00	ECCP-3F	10.00
			CCP-3OCF3	13.00
			CCP-5OCF3	10.00
			BCH-52F	5.00

	Example 24		Example 25	
N-I	+ 82°		+ 86 °	
Δn	+0.1198		+0.1221	
V_{10}	2.02		1.96	
	PCH-3	22.00	PCH-3	22.00
	PCH-4	15.00	PCH-4	20.00
	PCH-53	5.00	PTP-201	5.00
	PTP-201	6.00	CCP-3OCF3	14.00
	CCP-3OCF3	14.00	CCP-5OCF3	12.00
	CCP-5OCF3	12.00	ECCP-3F	13.00
	ECCP-3F	13.00	BCH-52F	14.00
	BCH-52F	13.00		

	Example 26 a)		Example 26 b)	
N-I	+ 83°		+ 86 °	
Δn	+0.1211		+0.1229	
V_{10}	1.94		2.00	
	PCH-3	22.00	PCH-3	22.00
	PCH-4	20.00	PCH-4	20.00
	PCH-53	2.00	PTP-201	6.00
	PTP-201	5.00	CCP-3OCF3	14.00
	CCP-3OCF3	14.00	ECCP-3F	13.00
	CCP-5OCF3	12.00	ECCP-5F	12.00
	ECCP-3F	12.00	BCH-52F	13.00
	BCH-52F	13.00		

	Example 27		Example 28	
N-I	+ 92°		+ 84 °	
Δn	+0.1347		+0.1272	
V_{10}	1.86		1.86	
	K6	7.00	ME2N.F	2.00
	PCH-2	3.00	G9	10.00
	PCH-3	22.00	PCH-3	21.00
	PCH-5	10.00	PCH-4	12.00
	PCH-301	6.00	PCH-5	10.00
	CCP-2OCF3	6.00	PCH-301	2.00
	CCP-3OCF3	6.00	CPTP-301	4.00
	CCP-4OCF3	6.00	CPTP-302	5.00
	CCP-5OCF3	6.00	CCP-2OCF3	7.00
	ECCP-3OCF3	4.00	CCP-3OCF3	7.00
	ECCP-5OCF3	4.00	CCP-4OCF3	7.00
	ECCP-3F.F	4.00	CCP-5OCF3	7.00
	ECCP-5F.F	4.00	ECCP-33	6.00
	CPTP-301	4.00		
	CPTP302	4.00		
	CPTP-303	4.00		

	Example 29		Example 30	
N-I	+ 84°		+ 86 °	
Δn	+0.1288		+0.1295	
V_{10}	1.80		1.80	
	ME2N.F	2.00	ME2N.F	2.00
	PCH-3	21.00	PCH-3	21.00
	PCH-4	12.00	PCH-4	12.00
	PCH-5	20.00	PCH-5	20.00
	PCH-301	2.00	PCH-301	4.00
	CPTP-301	4.00	CPTP-301	4.00
	CPTP-302	5.00	CPTP-302	5.00
	CCP-2OCF3	7.00	CCP-2OCF3	7.00
	CCP-3OCF3	7.00	CCP-3OCF3	7.00
	CCP-4OCF3	7.00	CCP-4OCF3	7.00
	CCP-5OCF3	7.00	CCP-5OCF3	7.00
	ECCP-33	6.00	ECCP-3	4.00

	Example 31		Example 32	
N-I	+ 92°		+ 78 °	
Δn	+0.1350		+0.1675	
V_{10}	1.95		2.04	
	K6	7.00	PCH-5F	9.00
	PCH-3	25.00	G9	16.00
	PCH-5	10.00	PCH-5	11.00
	PCH-301	6.00	K9	6.00
	CCP-2OCF3	5.00	K15	6.00
	CCP-3OCF3	5.00	PCH-302	8.00
	CCP-4OCF3	5.00	PTP-102	5.00
	CCP-5OCF3	5.00	PTP-201	6.00
	ECCP-3OCF3	4.00	CPTP-301	4.00
	ECCP-5OCF3	4.00	CPTP-302	4.00
	ECCP-3F.F	6.00	CPTP-303	4.00
	ECCP-5F.F	6.00	CCP-3OCF3	7.00
	CPTP-301	4.00	BCH-32	7.00
	CPTP-302	4.00	BCH-52	7.00
	CPTP-303	4.00		

	Example 33		Example 34	
N-I	+ 87°		+ 81 °	
Δn	+0.1262		+0.1267	
V_{10}	1.80		1.88	
	ME2N.F	2.00	PCH-2	7.00
	ME3N.F	2.00	PCH-3	28.00
	PCH-3	20.00	PCH-5	13.00
	PCH-4	12.00	PCH-302	9.00
	PCH-5	18.00	CCH-303	3.00
	CPTP-301	4.00	CCP-2OCF3	7.00
	CPTP-302	4.00	CCP-3OCF3	7.00
	CCP-2OCF3	8.00	CCP-4OCF3	7.00
	CCP-3OCF3	8.00	CCP-5OCF3	6.00
	CCP-4OCF3	8.00	CPTP-301	4.00
	CCP-5OCF3	8.00	CPTP-302	4.00
	ECCP-33	6.00	CPTP-303	4.00

	Example 35		Example 36	
N-I	+ 81°		+ 71 °	
Δn	+0.1527		+0.1695	
V_{10}	1.94		1.75	
	K6	3.00	PCH-3	16.00
	PCH-3	22.00	K6	9.00
	PCH-5	15.00	K9	6.00
	PCH-301	15.00	K15	6.00
	PTP-102	6.00	ME15	8.00
	PTP-201	6.00	PTP-102	8.00
	CCP-3OCF3	6.00	PTP-201	9.00
	CCP-5OCF3	6.00	CCP-3OCF3	13.00
	ECCP-3F	6.00	CCP-5OCF3	10.00
	ECCP-3	5.00	ECCP-3F	5.00
	CPTP-301	3.00	BCH-52F	10.00
	CPTP-302	3.00		
	CPTP-303	4.00		

	Example 37		Example 38	
N-I	+ 79°		+ 89 °	
Δn	+0.1545		+0.1744	
V_{10}	2.50		2.02	
	PCH-5F	6.00	PCH-3	20.00
	PCH-6F	6.00	PCH-5	18.00
	PCH-7F	5.00	BCH-5	6.00
	CCP-2OCF3	7.00	PTP-4OF	5.00
	CCP-3OCF3	10.00	PTP-102	8.00
	CCP-5OCF3	10.00	PTP-201	8.00
	BCH-3F.F	13.00	ECCP-3F	13.00
	BCH-5F.F	13.00	CPTP-301	5.00
	PTP-4OF	10.00	BCH-32	2.00
	PTP-6OF	8.00	BCH-52F	15.00
	PTP-102	5.00		
	PTP-201	5.00		
	CPTP-301	2.00		

	Example 39		Example 40	
N-I	+ 70°		+ 77 °	
Δn	+0.1680		+0.1388	
V_{10}	1.91		2.01	
	PCH-3	24.00	PCH-3	23.00
	K6	6.00	PCH-5	14.00
	PCH-302	12.00	PCH-301	17.00
	PTP-40F	5.00	CCP-30CF3	4.00
	PTP-102	8.00	ECCP-3	5.00
	PTP-201	8.00	ECCP-31	5.00
	CCP-30CF3	10.00	ECCP-32	4.00
	BCH-32	10.00	ECCP-33	4.00
	BCH-52F	14.00	PTP-102	6.00
			PTP-201	6.00
			BCH-32	6.00
			BCH-52	6.00

	Example 41		Example 42	
N-I	+ 78°		+ 78 °	
Δn	+0.1382		+0.1437	
V_{10}	1.38		2.14	
	ME2N.F	2.00	K9	12.00
	ME3N.F	4.00	PCH-5	22.00
	ME5N.F	5.00	PCH-5F	8.00
	HP-3N.F	3.00	PCH-7F	8.00
	HP-4N.F	4.00	CCP-30CF3	5.00
	HP-5N.F	5.00	CCP-50CF3	5.00
	K6	6.00	ECCP-31	5.00
	PCH-3	23.00	ECCP-32	5.00
	PCH-5	20.00	ECCP-33	5.00
	CCP-30CF3	9.00	ECCP-35	5.00
	CCP-40CF3	8.00	PTP-201	5.00
	CCP-50CF3	9.00	PTP-102	5.00
	CPTP-302	2.00	CPTP-302	5.00
			BCH-52	5.00

	Example 43		Example 44	
N-I	+ 79°		+ 78 °	
Δn	+0.1517		+0.1608	
V_{10}	2.12		1.99	
	K6	6.00	K6	2.00
	K9	12.00	K9	12.00
	PCH-5	16.00	PCH-5	11.00
	PCH-5F	8.00	PCH-5F	8.00
	PCH-7F	7.00	PCH-7F	7.00
	CCP-3OCF3	5.00	CCP-3OCF3	5.00
	CCP-5OCF3	5.00	CCP-5OCF3	5.00
	ECCP-31	6.00	ECCP-31	6.00
	ECCP-32	5.00	ECCP-32	5.00
	ECCP-33	5.00	ECCP-33	5.00
	ECCP-35	5.00	PTP-201	5.00
	PTP-201	5.00	PTP-102	5.00
	PTP-102	5.00	CPTP-302	5.00
	CPTP-302	5.00	BCH-32	5.00
	BCH-52	5.00	BCH-52	5.00

	Example 45		Example 46	
N-I	+ 88°		+ 70 °	
Δn	+0.1453		+0.1651	
V_{10}	1.84		1.92	
	ME2N.F	2.00	PCH-3	14.00
	ME3N.F	3.00	K6	7.00
	K6	8.00	K9	7.00
	PCH-3	21.00	PCH-53	3.00
	PCH-5	24.00	PCH-302	11.00
	CPTP-301	6.00	PTP-4OF	7.00
	CPTP-302	5.00	PTP-102	7.00
	CCP-2OCF3	6.00	PTP-201	8.00
	CCP-3OCF3	5.00	ECCP-3F	5.00
	CCP-4OCF3	6.00	CCP-3OCF3	10.00
	CCP-5OCF3	5.00	CCP-5OCF3	8.00
	ECCP-31	5.00	BCH-32	5.00
	ECCP-32	4.00	BCH-52F	10.00

	Example 47		Example 48	
N-I	+ 76°		+ 73 °	
Δn	+0.1382		+0.1381	
V_{10}	1.30		-	
	ME2N.F	3.00	PCH-3	23.00
	ME3N.F	4.00	G9	14.00
	ME5N.F	6.00	PCH-301	17.00
	HP-3N.F	3.00	CCP-3OCF3	4.00
	HP-4N.F	4.00	ECCP-3	5.00
	HP-5N.F	5.00	ECCP-31	5.00
	K6	5.00	ECCP-32	4.00
	PCH-3	23.00	ECCP-33	4.00
	PCH-5	21.00	PTP-102	6.00
	CCP-3OCF3	8.00	PTP-201	6.00
	CCP-4OCF3	8.00	BCH-32	6.00
	CCP-5OCF3	8.00	BCH-52	6.00
	CPTP-302	2.00		

	Example 49		Example 50	
N-I	+ 84°		+103 °	
Δn	+0.1396		+0.1484	
V_{10}	1.64		2.02	
	K6	7.00	K6	7.00
	ME2N.F	3.00	PCH-3	28.00
	ME3N.F	3.00	PCH-4	5.00
	ME5N.F	3.00	PCH-5	5.00
	PCH-3	12.00	PCH-301	4.00
	PCH-4	8.00	CCP-2OCF3	8.00
	PCH-5	10.00	CCP-3OCF3	8.00
	PCH-301	9.00	CCP-4OCF3	5.00
	CCP-2OCF3	8.00	CCP-5OCF3	6.00
	CCP-3OCF3	8.00	CPTP-301	5.00
	CCP-4OCF3	8.00	CPTP-302	6.00
	CCP-5OCF3	8.00	CPTP-303	3.00
	CPTP-301	5.00	ECCP-3	10.00
	CPTP-302	4.00		
	CPTP-303	4.00		

	Example 51		Example 52	
N-I	+ 69°		+ 71 °	
Δn	+0.1387		+0.1458	
V_{10}	1.68		1.69	
	PCH-3	22.00	PCH-3	20.00
	PCH-4	17.00	PCH-4	10.00
	PCH-5	6.0	K6	9.0
	K6	9.0	K9	9.0
	K9	3.0	K15	12.0
	PTP-35	5.0	BCH-5	2.0
	CCP-30CF3	12.0	CCP-30CF3	14.0
	CCP-50CF3	10.0	CCP-50CF3	10.0
	BCH-32	5.0	ECCP-3F	14.0
	BCH-52F	11.0		

	Example 53		Example 54	
N-I	+ 69°		+ 71 °	
Δn	+0.1665		+0.1391	
V_{10}	1.94		1.67	
	PCH-3	20.00	PCH-3	20.00
	PCH-5	4.0	PCH-4	12.0
	K6	6.0	K6	9.0
	PCH-302	12.0	K9	9.0
	PTP-35	9.0	K15	9.0
	PTP-102	7.0	CCP-30CF3	15.0
	PTP-201	8.0	CCP-50CF3	12.0
	CCP-30CF3	8.0	ECCP-3F	14.0
	BCH-32	10.0		
	BCH-52F	16.0		

	Example 55		Example 56	
N-I	+ 70°		+ 69 °	
Δn	+0.1398		+0.1383	
V_{10}	1.74		1.74	
	K6	7.00	K6	7.00
	PCH-3	28.0	PCH-3	25.0
	PCH-5	13.0	PCH-5	13.0
	PCH-301	11.0	PCH-5F	5.0
	CCP-2OCF3	8.0	PCH-301	8.0
	CCP-3OCF3	6.0	CCP-2OCF3	8.0
	CCP-4OCF3	5.0	CCP-3OCF3	5.0
	CCP-5OCF3	4.0	CCP-4OCF3	5.0
	ECCP-32	4.0	CCP-5OCF3	4.0
	PTP-102	4.0	ECCP-32	5.0
	PTP-201	4.0	PTP-102	4.0
	CPTP-301	3.0	PTP-201	4.0
	CPTP-302	3.0	CPTP-301	3.0
			CPTP-302	4.0

	Example 57		Example 58	
N-I	+ 72°		+ 68 °	
Δn	+0.1431		+0.1418	
V_{10}	1.80		1.85	
	K6	7.0	PYP-3F	5.0
	PCH-3	25.0	PYP-5F	9.0
	PCH-5	11.0	PCH-5F	9.0
	PCH-5F	10.0	PCH-3	21.0
	PCH-301	7.0	PCH-301	12.0
	CCP-3OCF3	9.0	CCP-3OCF3	4.0
	CCP-5OCF3	8.0	CCP-5OCF3	4.0
	ECCP-3	9.0	ECCP-32	4.0
	PTP-102	4.0	ECCP-33	4.0
	PTP-201	4.0	ECCP-3	8.0
	CPTP-301	3.0	PTP-102	4.0
	CPTP-302	4.0	PTP-201	4.0
			CPTP-301	6.0
			CPTP-302	6.0

	Example 59		Example 60	
N-I	+ 71°		+ 84 °	
Δn	+0.1674		+0.1294	
V_{10}	1.98		1.85	
	K6	8.0	PCH-2	9.0
	K9	9.0	PCH-3	22.0
	K12	6.0	PCH-5	14.0
	PCH-3	3.0	PCH-301	9.0
	PCH-53	4.0	CCP-2OCF3	8.0
	PCH-302	10.0	CCP-3OCF3	8.0
	PTP-35	8.0	CCP-4OCF3	5.0
	PTP-102	7.0	CCP-5OCF3	6.0
	PTP-201	7.0	PTP-102	6.0
	ECCP-3F	10.0	CPTP-301	5.0
	CCP-3OCF3	13.0	CBC-33F	4.0
	CCP-5OCF3	10.0	CBC-53F	4.0
	BCH-52F	5.0		

	Example 61		Example 62	
N-I	+ 70°		+ 72 °	
Δn	+0.1590		+0.1424	
V_{10}	1.67		1.97	
	K6	7.0	PYP-3F	5.0
	K9	10.0	PYP-5F	8.0
	PCH-2	8.0	PCH-5F	9.0
	PCH-3	14.0	PCH-3	21.0
	PCH-301	13.0	PCH-301	11.0
	CCP-2OCF3	8.0	CCP-3OCF3	4.0
	CCP-3OCF3	8.0	CCP-5OCF3	5.0
	CCP-4OCF3	5.0	ECCP-32	5.0
	CCP-5OCF3	6.0	ECCP-33	4.0
	PTP-102	6.0	ECCP-3	8.0
	PTP-201	6.0	PTP-102	4.0
	CPTP-301	5.0	PTP-201	4.0
	CPTP-302	4.0	CPTP-301	6.0
			CPTP-302	6.0

	Example 63		Example 64	
N-I	+ 71°		+ 76 °	
Δn	+0.1397		+0.1401	
V_{10}	1.79		1.68	
	K6	7.0	PCH-3	20.0
	PCH-3	23.0	PCH-4	6.0
	PCH-5	13.0	K6	9.0
	PCH-5F	5.0	K9	9.0
	PCH-301	9.0	K15	10.0
	CCP-2OCF3	8.0	CCP-3OCF3	15.0
	CCP-3OCF3	5.0	CCP-4OCF3	5.0
	CCP-4OCF3	5.0	CCP-5OCF3	12.0
	CCP-5OCF3	4.0	ECCP-3F	14.0
	ECCP-32	5.0		
	PTP-102	4.0		
	PTP-201	4.0		
	CPTP-301	4.0		
	CPTP-302	4.0		

	Example 65		Example 66	
N-I	+ 81°		+ 70 °	
Δn	+0.1355		+0.1407	
V_{10}	1.82		1.64	
	PCH-3	22.0	PCH-3	20.0
	PCH-4	17.0	PCH-4	16.0
	K6	6.0	PCH-5	7.0
	PCH-302	7.0	K6	9.0
	PTP-201	6.0	K9	9.0
	CCP-3OCF3	14.0	BCH-5	3.0
	CCP-5OCF3	12.0	PTP-201	3.0
	ECCP-3F	10.0	CCP-3OCF3	15.0
	CPTP-301	6.0	CCP-5OCF3	12.0
			ECCP-3F	6.0

	Example 67		Example 68	
N-I	+ 81°		+ 77 °	
Δn	+0.1329		+0.1622	
V_{10}	1.93		-	
	PCH-3	22.0	PCH-3	20.0
	PCH-4	17.0	PCH-4	6.0
	PCH-302	9.0	K6	9.0
	PTP-102	5.0	K9	7.0
	PTP-201	6.0	PTP-102	8.0
	CCP-3OCF3	14.0	PTP-201	8.0
	CCP-5OCF3	12.0	CCP-3OCF3	18.0
	ECCP-3F	11.0	CCP-5OCF3	14.0
	CPTP-301	4.0	BCH-52F	10.0

	Example 69		Example 70	
N-I	+ 91°		+ 87 °	
Δn	+0.1603		+0.1724	
V_{10}	1.94		1.99	
	K6	7.0	PCH-5F	4.0
	K9	10.0	PCH-3	17.0
	PCH-2	9.0	PCH-5	12.0
	PCH-3	14.0	K9	6.0
	PCH-301	9.0	K15	4.0
	CCP-3OCF3	8.0	PCH-302	10.0
	CCP-5OCF3	8.0	PTP-102	5.0
	ECCP-33	6.0	PTP-201	7.0
	ECCP-3F	6.0	CPTP-301	5.0
	ECCP-3	5.0	CPTP-302	4.0
	PTP-201	5.0	CPTP-303	6.0
	CPTP-301	4.0	CCP-3OCF3	7.0
	CPTP-302	4.0	CCP-5OCF3	7.0
	CPTP-303	5.0	BCH-32	6.0

	Example 71		Example 72	
N-I	+ 89°		+ 81 °	
Δn	+0.1235		+0.1202	
V_{10}	1.59		2.41	
	ME2N.F	2.0	PCH-6F	5.0
	ME3N.F	3.0	PCH-7F	15.0
	PCH-3	12.0	CCP-3OCF3	15.0
	PCH-5	8.0	CCP-5OCF3	13.0
	PCH-302	14.0	BCH-3F.F	14.0
	CCP-3OCF3	12.0	BCH-5F.F	16.0
	CCP-5OCF3	11.0	BEP-3CL.F	6.0
	BCH-3F.F	12.0	BEP-5CL.F	8.0
	BCH-5F.F	10.0	BCH-52F	6.0
	BCH-32	6.0		
	BCH-52	5.0		
	BCH-52F	5.0		

	Example 73		Example 74	
N-I	+ 87°		+ 76 °	
Δn	+0.1228		+0.1414	
V_{10}	2.59		1.81	
	PCH-6F	5.0	K6	8.0
	PCH-7F	15.0	PCH-3	25.0
	CCP-3OCF3	15.0	PCH-5	10.0
	CCP-5OCF3	13.0	PCH-301	12.0
	BCH-3F.F	14.0	CCP-3OCF3	8.0
	BCH-5F.F	16.0	CCP-5OCF3	8.0
	PTP-201	7.0	ECCP-3	7.0
	BCH-52F	15.0	ECCP-3F	7.0
			ECCP-32	3.0
			PTP-102	5.0
			PTP-201	5.0
			CPTP-302	2.0

	Example 75		Example 76	
N-I	+ 77°		+ 73 °	
Δn	+0.1456		+0.1422	
V_{10}	1.87		1.96	
	PCH-3	23.0	K6	8.0
	PCH-5	13.0	PCH-3	25.0
	PTP-40F	11.0	PCH-5	10.0
	PCH-301	9.0	PCH-301	12.0
	CCP-20CF3	7.0	CCP-30CF3	8.0
	CCP-30CF3	5.0	CCP-50CF3	8.0
	CCP-40CF3	5.0	ECCP-3	7.0
	CCP-50CF3	5.0	ECCP-31	5.0
	ECCP-3	3.0	ECCP-32	5.0
	PTP-102	5.0	PTP-102	6.0
	PTP-102	4.0	PTP-201	6.0
	PTP-201	4.0		
	CPTP-301	4.0		

	Example 77		Example 78	
N-I	+ 71°		+ 72 °	
Δn	+0.1411		+0.1430	
V_{10}	1.90		1.92	
	PCH-3	23.0	K6	8.0
	PCH-5	14.0	PCH-3	25.0
	PTP-40F	8.0	PCH-5	10.0
	PCH-301	11.0	PCH-301	14.0
	CCP-20CF3	7.0	CCP-30CF3	6.0
	CCP-30CF3	5.0	CCP-50CF3	6.0
	CCP-50CF3	5.0	ECCP-3	9.0
	ECCP-3	5.0	ECCP-31	5.0
	ECCP-31	5.0	ECCP-32	5.0
	ECCP-32	5.0	PTP-102	6.0
	PTP-102	6.0	PTP-201	6.0
	PTP-201	6.0		

	Example 79		Example 80	
N-I	+ 72°		+ 92 °	
Δn	+0.1406		+0.1333	
V_{10}	1.96		2.24	
	PTP-4OF	8.0	PCH-3	20.0
	PCH-3	23.0	PCH-5	16.0
	PCH-5	14.0	CCP-3OCF3	8.0
	PCH-301	13.0	CCP-5OCF3	7.0
	CCP-3OCF3	7.0	PCH-301	15.0
	CCP-5OCF3	7.0	ECCP-3	10.0
	ECCP-3	7.0	ECCP-31	6.0
	ECCP-31	5.0	ECCP-32	6.0
	ECCP-32	5.0	PTP-102	6.0
	PTP-102	5.0	CPTP-302	6.0
	PTP-201	6.0		

	Example 81		Example 82	
N-I	+ 74°		+ 75 °	
Δn	+0.1411		+0.1393	
V_{10}	1.95		1.81	
	K6	7.0	K6	7.0
	PCH-3	25.0	PCH-3	25.0
	PCH-5	10.0	PCH-5	19.0
	PCH-301	13.0	PCH-301	12.0
	CCP-3OCF3	8.0	CCP-3OCF3	10.0
	ECCP-3	6.0	CCP-5OCF3	11.0
	ECCP-31	7.0	ECCP-3	6.0
	ECCP-32	6.0	PTP-102	5.0
	ECCP-33	6.0	CPTP-302	5.0
	PTP-102	6.0		
	PTP-201	6.0		

	Example 83		Example 84	
N-I	+ 76°		+ 76 °	
Δn	+0.1379		+0.1378	
V_{10}	2.00		1.76	
	K6	9.0	ME2N.F	2.0
	PCH-3	24.0	K6	6.0
	PCH-5	10.0	PCH-3	24.0
	PCH-301	13.0	PCH-5	19.0
	CCP-3OCF3	8.0	PCH-301	12.0
	ECCP-3	8.0	CCP-3OCF3	10.0
	ECCP-31	5.0	CCP-5OCF3	11.0
	ECCP-32	5.0	ECCP-3	7.0
	ECCP-33	5.0	PTP-102	4.0
	ECCP-35	5.0	CPTP-302	5.0
	PTP-102	4.0		
	PTP-201	4.0		

	Example 85		Example 86	
N-I	+ 77°		+ 81 °	
Δn	+0.1353		+0.1385	
V_{10}	2.01		1.84	
	K6	8.0	K6	7.0
	PCH-3	24.0	PCH-3	28.0
	PCH-5	11.0	PCH-5	13.0
	PCH-301	13.0	PCH-301	12.0
	CCP-3OCF3	8.0	CCP-2OCF3	8.0
	ECCP-3	8.0	CCP-3OCF3	8.0
	ECCP-31	5.0	CCP-4OCF3	5.0
	ECCP-32	5.0	CCP-5OCF3	6.0
	ECCP-33	5.0	CPTP-301	5.0
	ECCP-35	5.0	CPTP-302	4.0
	PTP-102	4.0	CPTP-303	4.0
	PTP-201	4.0		

	Example 87		Example 88	
N-I	+ 77°		+ 77 °	
Δn	+0.1322		+0.1281	
V_{1c}	1.98		2.05	
	K6	9.0	K6	9.0
	PCH-3	20.0	PCH-3	20.0
	PCH-5	14.0	PCH-5	10.0
	PCH-301	9.0	PCH-5F	6.0
	CCP-30CF3	9.0	PCH-301	11.0
	CCP-50CF3	9.0	CCP-30CF3	8.0
	ECCP-31	5.0	CCP-50CF3	8.0
	ECCP-32	6.0	ECCP-31	5.0
	ECCP-33	6.0	ECCP-32	5.0
	ECCP-35	5.0	ECCP-33	6.0
	PTP-102	4.0	ECCP-35	5.0
	PTP-201	4.0	PTP-102	4.0
			CPTP-302	4.0

	Example 89		Example 90	
N-I	+ 83°		+ 84 °	
Δn	+0.1698		+0.1273	
V_{10}	2.03		2.25	
	PCH-5F	9.0	PCH-6F	6.0
	PCH-3	14.0	PCH-7F	5.0
	PCH-5	9.0	PYP-5F	5.0
	K9	6.0	CCP-30CF3	15.0
	K15	6.0	CCP-50CF3	13.0
	PCH-302	9.0	ECCP-3F.F	4.0
	PTP-102	5.0	BCH-3F.F	18.0
	PTP-201	7.0	BCH-5F.F	14.0
	CPTP-301	5.0	BEP-3ClF	10.0
	CPTP-302	4.0	BEP-5ClF	10.0
	CPTP-303	6.0		
	CCP-30CF3	7.0		
	CCP-50CF3	7.0		
	BCH-32	6.0		

	Example 91		Example 92	
N-I	+ 82°		+ 75 °	
Δn	+0.1286		+0.1353	
V_{10}	2.22		2.06	
	PCH-6F	6.0	K6	12.0
	PCH-7F	10.0	PCH-3	22.0
	CCP-3OCF3	15.0	PCH-5F	10.0
	CCP-5OCF3	7.0	PCH-301	5.0
	EHP-5F.F	10.0	CCP-3OCF3	7.0
	BCH-3F.F	18.0	CCP-5OCF3	6.0
	BCH-5F.F	14.0	ECCP-31	6.0
	BEP-3ClF	10.0	ECCP-32	6.0
	BEP-5ClF	10.0	ECCP-33	6.0
			ECCP-35	6.0
			PTP-102	6.0
			CPTP-302	5.0

	Example 93		Example 94	
N-I	+ 76°		+ 77 °	
Δn	+0.1371		+0.1371	
V_{10}	1.71		1.64	
	ME2N.F	2.0	ME2N.F	2.0
	ME3N.F	3.0	ME3N.F	3.0
	K6	4.0	K6	6.0
	PCH-3	24.0	PCH-3	24.0
	PCH-5	18.0	PCH-5	16.0
	PCH-301	12.0	PCH-301	6.0
	CCP-3OCF3	10.0	CCP-3OCF3	11.0
	CCP-5OCF3	11.0	CCP-4OCF3	11.0
	ECCP-3	7.0	CCP-5OCF3	11.0
	PTP-102	4.0	PTP-102	5.0
	CPTP-302	5.0	CPTP-302	5.0

	Example 95		Example 96	
N-I	+ 80°		+ 77 °	
Δn	+0.1689		+0.1368	
V_{10}	1.96		2.03	
	PCH-5F	9.0	K6	6.0
	PCH-3	16.0	K9	6.0
	PCH-5	11.0	PCH-3	12.0
	K9	6.0	PCH-5	10.0
	K15	6.0	PCH-5F	9.0
	PCH-302	8.0	PCH-301	8.0
	PTP-102	5.0	CCP-30CF3	7.0
	PTP-201	6.0	CCP-50CF3	6.0
	CPTP-301	4.0	ECCP-31	6.0
	CPTP-302	4.0	ECCP-32	6.0
	CPTP-303	4.0	ECCP-33	6.0
	CCP-30CF3	7.0	ECCP-35	5.0
	BCH-32	7.0	PTP-201	4.0
	BCH-52	7.0	PTP-102	4.0
			CPTP-302	5.0

	Example 97		Example 98	
N-I	+ 79°		+ 75 °	
Δn	+0.1399		+0.1364	
V_{10}	2.22		1.62	
	PTP-40F	6.0	ME2N.F	2.0
	K9	6.0	ME3N.F	3.0
	PCH-3	12.0	K6	6.0
	PCH-5	10.0	PCH-3	24.0
	PCH-5F	7.0	PCH-5	16.0
	PCH-301	10.0	PCH-301	5.0
	CCP-30CF3	7.0	CCP-20CF3	8.0
	CCP-50CF3	6.0	CCP-30CF3	9.0
	ECCP-31	6.0	CCP-40CF3	8.0
	ECCP-32	6.0	CCP-50CF3	9.0
	ECCP-33	6.0	PTP-102	5.0
	ECCP-35	6.0	CPTP-302	5.0
	PTP-201	4.0		
	PTP-102	4.0		
	CPTP-302	5.0		

	Example 99		Example 100	
N-I	+ 93°		+ 79 °	
Δn	+0.1412		+0.1343	
V_{10}	1.77		1.94	
	K6	7.0	PCH-2	8.0
	PCH-3	28.0	PCH-3	17.0
	PCH-4	8.0	PCH-5	10.0
	PCH-5	13.0	PCH-301	11.0
	PCH-301	4.0	CCP-2OCF3	7.0
	CCP-2OCF3	8.0	CCP-3OCF3	7.0
	CCP-3OCF3	8.0	CCP-4OCF3	7.0
	CCP-4OCF3	5.0	CCP-5OCF3	7.0
	CCP-5OCF3	6.0	ECCP-3	5.0
	CPTP-301	5.0	ECCP-32	5.0
	CPTP-302	4.0	PTP-102	6.0
	CPTP-303	4.0	PTP-201	6.0
			CPTP-303	4.0

	Example 101		Example 102	
N-I	+ 80°		+100 °	
Δn	+0.1606		+0.2005	
V_{10}	1.94		2.91	
	PCH-2	5.0	PCH-5F	7.0
	K6	7.0	PCH-7F	6.0
	K9	8.0	BCH-3F.F	14.0
	K15	9.0	BCH-5F.F	13.0
	PCH-301	15.0	PTP-4OF	10.0
	CCP-2OCF3	7.0	PTP-3OF	10.0
	CCP-3OCF3	7.0	PTP-102	6.0
	CCP-4OCF3	7.0	PTP-201	6.0
	CCP-5OCF3	7.0	CPTP-301	5.0
	ECCP-3	6.0	CPTP-302	5.0
	ECCP-32	5.0	CPTP-303	6.0
	PTP-102	6.0	CCP-3OCF3	6.0
	PTP-201	6.0	CCP-5OCF3	6.0
	CPTP-303	4.0		

	Example 103		Example 104	
N-I	+ 77°		+ 78 °	
Δn	+0.1340		+0.1315	
V_{10}	2.02		2.09	
	K6	9.0	K6	9.0
	PCH-3	22.0	PCH-3	22.0
	PCH-5	10.0	PCH-5	10.0
	PCH-301	13.0	PCH-301	10.0
	CCP-3OCF3	9.0	CCP-3OCF3	9.0
	ECCP-3	5.0	ECCP-3F	4.0
	ECCP-31	6.0	ECCP-5F	4.0
	ECCP-32	6.0	ECCP-31	6.0
	ECCP-33	6.0	ECCP-32	6.0
	ECCP-35	6.0	ECCP-33	6.0
	PTP-102	4.0	ECCP-35	6.0
	PTP-201	4.0	PTP-102	4.0
			PTP-201	4.0

	Example 105		Example 106	
N-I	+ 77°		+ 76 °	
Δn	+0.1380		+0.1389	
V_{10}	2.07		1.61	
	K6	6.0	ME2N.F	2.0
	K9	5.0	ME3N.F	4.0
	PCH-3	12.0	K6	6.0
	PCH-5	12.0	PCH-3	26.0
	PCH-5F	8.0	PCH-5	14.0
	PCH-6F	4.0	PCH-301	3.0
	PCH-301	3.0	CCP-2OCF3	8.0
	CCP-3OCF3	7.0	CCP-3OCF3	9.0
	CCP-5OCF3	6.0	CCP-4OCF3	9.0
	ECCP-31	6.0	CCP-5OCF3	9.0
	ECCP-32	6.0	PTP-102	5.0
	ECCP-33	6.0	CPTP-302	5.0
	ECCP-35	5.0		
	PTP-201	5.0		
	PTP-102	4.0		
	CPTP-302	5.0		

	Example 107		Example 108	
N-I	+ 76°		+ 71 °	
Δn	+0.1378		+0.1401	
V_{10}	1.52		1.70	
	ME2N.F	2.0	K6	7.0
	ME3N.F	4.0	PCH-3	28.0
	ME5N.F	5.0	PCH-5	13.0
	K6	6.0	PCH-301	11.0
	PCH-3	27.0	CCP-2OCF3	8.0
	PCH-5	14.0	CCP-3OCF3	8.0
	CCP-2OCF3	8.0	CCP-4OCF3	5.0
	CCP-3OCF3	9.0	CCP-5OCF3	6.0
	CCP-4OCF3	8.0	PTP-102	8.0
	CCP-5OCF3	9.0	CPTP-301	6.0
	PTP-102	2.0		
	CPTP-302	6.0		

	Example 109		Example 110	
N-I	+ 90°		+ 77 °	
Δn	+0.1334		+0.1373	
V_{10}	1.88		2.04	
	PCH-3	22.0	K6	8.0
	PCH-4	16.0	PCH-3	22.0
	PCH-5	8.0	PCH-5	10.0
	HP.3N.F	4.0	PCH-301	13.0
	BCH-5	6.0	CCP-3OCF3	8.0
	PTP-201	5.0	ECCP-3	6.0
	ECCP-3F	12.0	ECCP-31	6.0
	ECCP-5F	9.0	ECCP-32	6.0
	CCP-3OCF3	8.0	ECCP-33	6.0
	BCH-52F	10.0	ECCP-35	5.0
			PTP-102	5.0
			PTP-201	5.0

	Example 111		Example 112	
N-I	+ 75°		+ 76 °	
Δn	+0.1366		+0.1358	
V_{10}	1.97		1.56	
	K6	10.0	ME2N.F	2.0
	PCH-3	22.0	ME3N.F	4.0
	PCH-5	10.0	K6	5.0
	PCH-301	10.0	PCH-3	26.0
	CCP-3OCF3	8.0	PCH-5	14.0
	ECCP-3F	3.0	PCH-301	4.0
	ECCP-5F	3.0	CCP-2OCF3	8.0
	ECCP-31	6.0	CCP-3OCF3	9.0
	ECCP-32	6.0	CCP-4OCF3	9.0
	ECCP-33	6.0	CCP-5OCF3	9.0
	ECCP-35	6.0	PTP-102	5.0
	PTP-102	5.0	CPTP-302	5.0
	PTP-201	5.0		

	Example 113		Example 114	
N-I	+ 76°		+ 95 °	
Δn	+0.1385		+0.1851	
V_{10}	1.49		2.22	
	ME2N.F	2.0	K9	5.0
	ME3N.F	3.0	K12	5.0
	ME5N.F	5.0	PCH-3	10.0
	K6	6.0	PCH-5	7.0
	PCH-3	27.0	PCH-5F	7.0
	PCH-5	13.0	PCH-7F	7.0
	CCP-2OCF3	9.0	BCH-32	5.0
	CCP-3OCF3	9.0	BCH-52	6.0
	CCP-4OCF3	8.0	BCH-52F	7.0
	CCP-5OCF3	9.0	PTP-102	7.0
	PTP-201	3.0	PTP-201	8.0
	CPTP-302	6.0	CPTP-301	6.0
			CPTP-302	6.0
			CPTP-303	6.0
			CCP-3OCF3	4.0
			CCP-5OCF3	4.0

	Example 115		Example 116	
N-I	+ 74 °		+ 84 °	
Δn	+0.1310		+0.1287	
V_{10}	2.12		2.11	
	G9	5.0	PCH-3	7.0
	PCH-3	24.0	PCH-6F	5.0
	PCH-5	10.0	PCH-7F	5.0
	PCH-301	15.0	CCP-2OCF3	5.0
	CCP-3OCF3	8.0	CCP-3OCF3	9.0
	ECCP-31	5.0	CCP-4OCF3	5.0
	ECCP-32	5.0	CCP-5OCF3	8.0
	ECCP-33	4.0	ECCP-3F.F	4.0
	ECCP-35	4.0	BCH-3F.F	18.0
	PTP-102	5.0	BCH-5F.F	14.0
	PTP-201	5.0	BEP-3F.CL	10.0
	BCH-32	5.0	BEP-5F.Cl	10.0
	BCH-52	5.0		

	Example 117		Example 118	
N-I	+ 82 °		+ 74 °	
Δn	+0.1510		+0.1363	
V_{10}	1.65		1.97	
	K6	8.0	G9	10.0
	K9	8.0	PCH-3	24.0
	PCH-3	20.0	PCH-5	5.0
	PCH-4	10.0	PCH-301	13.0
	PCH-5	10.0	CCP-3OCF3	10.0
	PCH-301	4.0	CCP-5OCF3	5.0
	CCP-2OCF3	8.0	ECCP-31	4.0
	CCP-3OCF3	8.0	ECCP-32	5.0
	CCP-4OCF3	5.0	ECCP-33	4.0
	CCP-5OCF3	6.0	PTP-102	6.0
	CPTP-301	5.0	PTP-201	6.0
	CPTP-302	4.0	BCH-32	6.0
	CPTP-303	4.0	BCH-52	6.0

	Example 119		Example 120	
N-I	+ 75 °		+ 85 °	
Δn	+0.1432		+0.1341	
V_{10}	1.98		2.24	
	K6	8.0	K6	10.0
	K9	8.0	PCH-3	14.0
	PCH-3	16.0	PCH-5	8.0
	PCH-5	10.0	PCH-301	10.0
	PCH-301	10.0	CCP-3OCF3	10.0
	CCP-3OCF3	8.0	CCP-5OCF3	8.0
	ECCP-3F	3.0	ECCP-3F	3.0
	ECCP-5F	3.0	ECCP-5F	3.0
	ECCP-31	6.0	ECCP-31	6.0
	ECCP-32	6.0	ECCP-32	6.0
	ECCP-33	6.0	ECCP-33	6.0
	ECCP-35	6.0	ECCP-35	6.0
	PTP-102	5.0	PTP-102	5.0
	PTP-201	5.0	PTP-201	5.0

	Example 121		Example 122	
N-I	+ 72 °		+ 80 °	
Δn	+0.1357		+0.1424	
V_{10}	2.05		1.98	
	K6	10.0	K6	10.0
	PCH-3	17.0	PCH-3	22.0
	G9	15.0	PCH-5	10.0
	PCH-301	10.0	PCH-301	10.0
	CCP-3OCF3	8.0	CCP-3OCF3	8.0
	ECCP-3F	3.0	ECCP-3	10.0
	ECCP-5F	3.0	ECCP-3F	3.0
	ECCP-31	6.0	ECCP-5F	3.0
	ECCP-32	6.0	ECCP-33	7.0
	ECCP-33	6.0	ECCP-35	7.0
	ECCP-35	6.0	PTP-102	5.0
	PTP-102	5.0	PTP-201	5.0
	PTP-201	5.0		

	Example 123		Example 124	
N-I	+ 71 °		+ 99 °	
Δn	+0.1330		+0.1482	
V_{10}	1.94		1.70	
	K6	10.0	PCH-3	15.0
	PCH-3	22.0	PCH-5F	6.0
	PCH-5	10.0	CCP-2OCF3	9.0
	PCH-5F	10.0	CCP-3OCF3	10.0
	CCP-3OCF3	8.0	CCP-4OCF3	10.0
	ECCP-3F	3.0	CCP-5OCF3	10.0
	ECCP-5F	3.0	BCH-3F.F	11.0
	ECCP-31	6.0	BCH-5F.F	11.0
	ECCP-32	6.0	ECCP-3F.F	8.0
	ECCP-33	6.0	ECCP-5F.F	8.0
	ECCP-35	6.0	CBC-53F	2.0
	PTP-102	5.0		
	PTP-201	5.0		

	Example 125		Example 126	
N-I	+ 75 °		+ 76 °	
Δn	+0.1365		+0.1351	
V_{10}	2.09		2.19	
	G9	10.0	G9	10.0
	PCH-3	24.0	PCH-3	20.0
	PCH-5	5.0	PCH-5	5.0
	PCH-301	13.0	PCH-301	15.0
	CCP-3OCF3	5.0	CCP-3OCF3	6.0
	CCP-5OCF3	4.0	CCP-5OCF3	5.0
	ECCP-31	5.0	ECCP-31	5.0
	ECCP-32	5.0	ECCP-32	5.0
	ECCP-33	5.0	ECCP-33	5.0
	PTP-102	6.0	PTP-102	6.0
	PTP-201	6.0	PTP-201	6.0
	BCH-32	6.0	BCH-32	6.0
	BCH-52	6.0	BCH-52	6.0

	Example 127		Example 128	
N-I	+ 76 °		+ 76 °	
Δn	+0.1379		+0.1365	
V_{10}	1.52		1.54	
	ME2N.F	2.0	ME2N.F	2.0
	ME3N.F	4.0	ME3N.F	4.0
	ME5N.F	5.0	ME5N.F	5.0
	K6	5.0	K6	6.0
	PCH-3	27.0	PCH-3	27.0
	PCH-5	15.0	PCH-5	14.0
	CP-302FF	5.0	D-302FF	5.0
	CCP-20CF3	6.0	CCP-30CF3	10.0
	CCP-30CF3	7.0	CCP-40CF3	9.0
	CCP-40CF3	7.0	CCP-50CF3	10.0
	CCP-50CF3	9.0	CPTP-301	4.0
	PTP-102	4.0	CPTP-302	4.0
	CPTP-302	4.0		

	Example 129		Example 130	
N-I	+ 75 °		+ 76 °	
Δn	+0.1359		+0.1371	
V_{10}	1.60		1.67	
	HP.3N.F	2.0	ME2N.F	2.0
	HP.4N.F	4.0	ME3N.F	4.0
	ME2N.F	2.0	K6	5.0
	K6	4.0	PCH-3	26.0
	PCH-3	27.0	PCH-5	14.0
	PCH-4	11.0	PCH-301	7.0
	PCH-5	15.0	CP-302FF	5.0
	D-302FF	7.0	CCP-30CF3	9.0
	CCP-30CF3	10.0	CCP-40CF3	9.0
	CCP-50CF3	10.0	CCP-40CF3	9.0
	PTP-102	2.0	PTP-102	6.0
	CPTP-302	6.0	CPTP-302	4.0

	Example 131		Example 132	
N-I	+ 86 °		+ 82 °	
Δn	+0.1235		+0.1424	
V_{10}	1.92		2.10	
	PCH-3	22.0	K6	9.0
	PCH-4	20.0	PCH-3	24.0
	PTP-201	6.0	PCH-5	10.0
	CCP-3OCF3	14.0	PCH-301	9.0
	CCP-5OCF3	12.0	CCP-3OCF3	8.0
	ECCP-3F	13.0	ECCP-3	6.0
	BCH-52F	13.0	ECCP-31	5.0
			ECCP-32	5.0
			ECCP-33	5.0
			ECCP-35	3.0
			PTP-102	4.0
			PTP-201	4.0
			BCH-32	4.0
			BCH-52	4.0

	Example 133		Example 134	
N-I	+ 79 °		+ 80 °	
Δn	+0.1471		+0.1689	
V_{10}	2.15		1.96	
	K6	6.0	PCH-5F	9.0
	K9	6.0	PCH-3	16.0
	PCH-3	12.0	PCH-5	11.0
	PCH-5	10.0	K9	6.0
	PCH-5F	8.0	K15	6.0
	PCH-301	7.0	PCH-302	8.0
	CCP-3OCF3	7.0	PTP-102	5.0
	CCP-5OCF3	6.0	PTP-201	6.0
	ECCP-31	6.0	CPTP-301	4.0
	ECCP-32	5.0	CPTP-302	4.0
	ECCP-33	5.0	CPTP-303	4.0
	ECCP-35	5.0	CCP-3OCF3	7.0
	PTP-201	5.0	BCH-32	7.0
	PTP-102	6.0	BCH-52	7.0
	CPTP-302	6.0		

	Example 135		Example 136	
N-I	+ 82 °		+ 81 °	
Δn	+0.1458		+0.1465	
V_{10}	2.06		2.11	
	K6	9.0	K6	6.0
	PCH-3	24.0	K9	6.0
	PCH-5	10.0	PCH-3	12.0
	PCH-301	8.0	PCH-5	10.0
	CCP-3OCF3	8.0	PCH-5F	7.0
	ECCP-3	5.0	PCH-301	7.0
	ECCP-31	5.0	CCP-3OCF3	7.0
	ECCP-32	5.0	CCP-5OCF3	7.0
	ECCP-33	4.0	ECCP-31	6.0
	ECCP-35	3.0	ECCP-32	6.0
	PTP-102	4.0	ECCP-33	5.0
	PTP-201	5.0	ECCP-35	5.0
	BCH-32	5.0	PTP-201	5.0
	BCH-52	5.0	PTP-102	5.0
			CPTP-302	6.0

	Example 137		Example 138	
N-I	+ 81 °		+ 93 °	
Δn	+0.1281		+0.1350	
V_{10}	1.88		1.90	
	PCH-2	7.0	PCH-2	9.0
	PCH-3	28.0	PCH-3	22.0
	PCH-5	13.0	PCH-5	14.0
	PCH-302	12.0	PCH-301	11.0
	CCP-2OCF3	8.0	CCP-2OCF3	7.0
	CCP-3OCF3	8.0	CCP-3OCF3	7.0
	CCP-4OCF3	6.0	CCP-4OCF3	7.0
	CCP-5OCF3	6.0	ECCP-3	6.0
	CPTP-301	4.0	CPTP-301	4.0
	CPTP-302	4.0	CPTP-302	4.0
	CPTP-303	4.0	CPTP-303	5.0
			CBC-53F	4.0

	Example 139		Example 140	
N-I	+ 91 °		+ 74 °	
Δn	+0.1320		+0.1369	
V_{10}	1.86		1.86	
	PCH-2	9.0	K6	9.0
	PCH-3	22.0	PCH-2	12.0
	PCH-5	14.0	PCH-3	12.0
	PCH-301	11.0	PCH-5	10.0
	CCP-2OCF3	7.0	PCH-301	11.0
	CCP-3OCF3	7.0	PCH-302	11.0
	CCP-4OCF3	7.0	CCP-3OCF3	8.0
	CP-302FF	6.0	ECCP-3	8.0
	CPTP-301	4.0	ECCP-31	3.0
	CPTP-302	4.0	ECCP-32	4.0
	CPTP-303	5.0	ECCP-33	4.0
	CBC-53F	4.0	CPTP-301	4.0
			CPTP-302	4.0

	Example 141		Example 142	
N-I	+ 73 °		+ 75 °	
Δn	+0.1352		+0.1394	
V_{10}	1.92		2.10	
	K6	10.0	G9	10.0
	PCH-3	23.0	PCH-3	24.0
	PCH-5	10.0	PCH-5	5.0
	PCH-301	13.0	PCH-301	15.0
	PCH-302	12.0	CCP-3OCF3	5.0
	CCP-3OCF3	5.0	ECCP-3	5.0
	ECCP-3	8.0	ECCP-31	4.0
	ECCP-32	3.0	ECCP-32	4.0
	ECCP-33	3.0	ECCP-33	4.0
	BCH-32	4.0	PTP-102	6.0
	BCH-52	4.0	PTP-201	6.0
	CPTP-301	5.0	BCH-32	6.0
			BCH-52	6.0

	Example 143		Example 144	
N-I	+104 °		+ 93 °	
Δn	+0.1347		+0.1281	
V_{10}	2.01		1.97	
	PCH-2	9.0	PCH-2	9.0
	PCH-3	22.0	PCH-3	22.0
	PCH-5	14.0	PCH-5	14.0
	CCH-303	4.0	CCH-303	10.0
	CCP-20CF3	7.0	CCP-20CF3	7.0
	CCP-30CF3	7.0	CCP-30CF3	7.0
	CCP-40CF3	7.0	CCP-40CF3	7.0
	CCP-50CF3	7.0	CCP-50CF3	7.0
	ECCP-3	6.0	CPTP-301	5.0
	CPTP-301	4.0	CPTP-302	4.0
	CPTP-302	4.0	CPTP-303	5.0
	CPTP-303	5.0	CBC-53F	3.0
	CBC-53F	4.0		

	Example 145		Example 146	
N-I	+ 98 °		+ 93 °	
Δn	+0.1263		+0.1274	
V_{10}	2.11		1.86	
	ME2N.F	2.0	ME2N.F	2.0
	ME3N.F	3.0	ME3N.F	3.0
	ME5N.F	9.0	ME5N.F	7.0
	PCH-301	25.0	ME7N.F	7.0
	CCH-303	11.0	PCH-301	22.0
	CCP-20CF3	7.0	CCH-303	11.0
	CCP-30CF3	7.0	CCP-20CF3	7.0
	CCP-40CF3	7.0	CCP-30CF3	7.0
	CCP-50CF3	7.0	CCP-40CF3	7.0
	CPTP-301	5.0	CCP-50CF3	7.0
	CPTP-302	5.0	CPTP-301	5.0
	CPTP-303	5.0	CPTP-302	5.0
	CBC-33F	3.0	CPTP-303	5.0
	CBC-53F	4.0	CBC-53F	5.0

	Example 147		Example 148	
N-I	+ 76 °		+ 87 °	
Δn	+0.1442		+0.1432	
V_{10}	2.26		3.48	
	K9	12.0	PCH-3	5.0
	G9	22.0	PCH-302	15.0
	PCH-5F	7.0	PCH-304	10.0
	PCH-7F	7.0	PCH-305	10.0
	CCP-30CF3	6.0	PCH-501	10.0
	CCP-50CF3	6.0	CCP-20CF3	6.0
	ECCP-31	5.0	CCP-30CF3	6.0
	ECCP-32	5.0	CCP-40CF3	5.0
	ECCP-33	5.0	CCP-50CF3	6.0
	ECCP-35	5.0	PTP-102	5.0
	PTP-201	5.0	PTP-201	6.0
	PTP-102	5.0	CPTP-301	5.0
	CPTP-302	5.0	CPTP-302	5.0
	BCH-52	5.0	CPTP-303	6.0

	Example 149		Example 150	
N-I	+ 75 °		+ 85 °	
Δn	+0.1365		+0.1372	
V_{10}	2.10		1.88	
	PCH-3	23.0	PCH-3	15.0
	G9	20.0	PCH-4	16.0
	PCH-301	10.0	PCH-5	17.0
	PYP-34	4.0	PCH-53	5.0
	CCP-30CF3	4.0	CCP-20CF3	7.0
	ECCP-3	4.0	CCP-30CF3	8.0
	ECCP-31	6.0	CCP-40CF3	7.0
	ECCP-32	6.0	CCP-50CF3	8.0
	ECCP-33	6.0	PTP-102	3.0
	PTP-102	3.0	PTP-201	3.0
	PTP-201	3.0	CPTP-301	5.0
	CPTP-30CF3	5.0	CPTP-302	6.0
	CPTP-50CF3	6.0		

	Example 151		Example 152	
N-I	+ 87 °		+ 74 °	
Δn	+0.1423		+0.1394	
V_{10}	2.34		2.10	
	PCH-3	17.0	PCH-3	23.0
	G9	7.0	G9	14.0
	PCH-302	13.0	PCH-301	13.0
	PCH-501	6.0	PYP-34	5.0
	CCP-20CF3	8.0	CCP-30CF3	4.0
	CCP-30CF3	8.0	ECCP-3	3.0
	CCP-40CF3	5.0	ECCP-31	6.0
	CCP-50CF3	6.0	ECCP-32	6.0
	PTP-102	5.0	ECCP-33	6.0
	PTP-201	8.0	PTP-102	4.0
	CPTP-301	3.0	PTP-201	4.0
	CPTP-302	3.0	CPTP-30CF3	6.0
	CPTP-303	3.0	CPTP-50CF3	6.0
	ECCP-31	4.0		
	ECCP-32	4.0		

	Example 153		Example 154	
N-I	+ 96 °		+ 75 °	
Δn	+0.1301		+0.1355	
$\dot{V}_{10}$	1.96		2.09	
	PCH-2	9.0	G9	10.0
	PCH-3	22.0	PCH-3	24.0
	PCH-5	14.0	PCH-5	5.0
	CCH-303	11.0	PCH-301	10.0
	CCP-20CF3	5.0	CCH-303	3.0
	CCP-30CF3	6.0	CCP-30CF3	5.0
	CCP-40CF3	5.0	CCP-50CF3	4.0
	CCP-50CF3	6.0	ECCP-31	5.0
	ECCP-3	6.0	ECCP-32	5.0
	CPTP-301	4.0	ECCP-33	5.0
	CPTP-302	4.0	PTP-102	6.0
	CPTP-303	5.0	PTP-201	6.0
	CBC-53F	3.0	BCH-32	6.0
			BCH-52	6.0

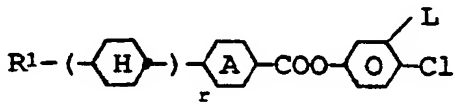
	Example 155		Example 156	
N-I	+ 72 °		+ 85 °	
Δn	+0.1375		+0.1394	
V_{10}	2.10		1.42	
	PCH-3	13.0	ME2N.F	2.0
	G9	24.0	ME3N.F	4.0
	PCH-301	17.0	ME5N.F	5.0
	CCP-3OCF3	4.0	HP-3N.F	3.0
	ECCP-3	5.0	HP-4N.F	4.0
	ECCP-31	5.0	HP-5N.F	5.0
	ECCP-32	4.0	PCH-3	24.0
	ECCP-33	4.0	PCH-5	22.0
	PTP-102	6.0	CCP-3OCF3	7.0
	PTP-201	6.0	CCP-4OCF3	7.0
	BCH-32	6.0	CCP-5OCF3	7.0
	BCH-52	6.0	CPTP-3OCF3	5.0
			CPTP-5OCF3	5.0

	Example 157		Example 158	
N-I	+ 75 °		+ 92 °	
Δn	+0.1372		+0.0837	
V_{10}	1.97		1.81	
	G9	10.0	PCH-5F	6.0
	PCH-3	24.0	PCH-6F	6.0
	PCH-5	7.0	PCH-7F	3.0
	ME15	10.0	CCH-303	3.0
	PCH-301	6.0	CCH-302	3.0
	CCP-3OCF3	5.0	CCP-2OCF3	9.0
	ECCP-3	5.0	CCP-3OCF3	9.0
	ECCP-31	5.0	CCP-4OCF3	9.0
	ECCP-32	5.0	CCP-5OCF3	9.0
	ECCP-33	4.0	ECCP-3F.F	9.0
	PTP-102	5.0	ECCP-5F.F	9.0
	PTP-201	4.0	ECCP-3OCF3	5.0
	BCH-32	5.0	EHP-3F.F	10.0
	BCH-52	5.0	EHP-5F.F	10.0

	Example 159	
N-I	+ 94 °	
Δn	+0.1169	
V_{10}	1.97	
	ME2N.F	2.0
	ME3N.F	2.0
	ME5N.F	5.0
	PCH-3	15.0
	PCH-5	10.0
	PCH-301	11.0
	CPTP-303	5.0
	CCP-2OCF3	9.0
	CCP-3OCF3	9.0
	CCP-5OCF3	9.0
	ECCP-31	5.0
	ECCP-32	5.0
	ECCP-33	5.0
	ECCP-35	4.0
	ECCP-3	4.0

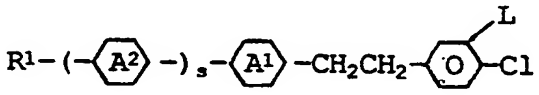
Claims

1. Supertwist liquid crystal display having
   - two plane-parallel carrier plates which, with an edging, form a cell,
   - a nematic liquid crystal mixture of positive dielectric anisotropy in the cell,
   - electrode layers with superimposed orientation layers on the inside of the carrier plates,
   - an angle of incidence between the longitudinal axis of the molecules on the surface of the carrier plates and the carrier plates of about 1 degree to 30 degrees and
   - the absolute amount of the twisting angle of the liquid crystal mixture in the cell from orientation layer to orientation layer being between 160 and 720 °, characterized in that the nematic liquid crystal mixture contains one or more compounds of the formula I



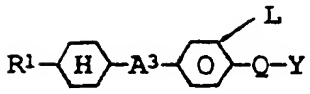
I

and/or one or more compounds of the formula II



II

and/or one or more compounds of the formula III

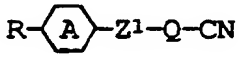


III

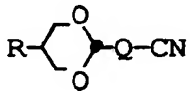
wherein R^1 is alkyl having 1-12 C atoms, wherein one or two non-adjacent CH_2 groups can also be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O-, r is 0 or 1, s is 0, 1 or 2, rings A^1 and A^2 are independently from each other trans-1,4-cyclohexylene, 1,4-phenylene or 3-fluoro-1,4-phenylene A^3 denotes - H -, $-CH_2CH_2-$ H - or - H $-CH_2CH_2-$, Q is OCHF, OCF_2, CF_2 or a single bond, Y is H, F or Cl and L denotes H or F.

2. Display according to claim 1, characterized in that the nematic liquid crystal mixture further comprises
a) 5-60 % by weight of a liquid crystalline component A consisting of one or more compounds having a dielectric anisotropy of more than +8,
b) 10-40 % by weight of a liquid crystalline component B consisting of one or more compounds having a clearing point of more than 120 °C, and
c) an optically active component C, in an amount such that the ratio between the layer thickness (separation of the plane-parallel carrier plates) and the natural pitch of the chiral nematic liquid crystal mixture is more than 0.2 adjusted to the desired twist angle,
and in that the nematic liquid crystal mixture has a nematic phase range of at least 60 °C, a viscosity of not more than 30 mPa.s and a dielectric anisotropy of at least +5, the dielectric anisotropies of the compounds and the parameters relating to the nematic liquid crystal mixture being based on a temperature of 20 °C.

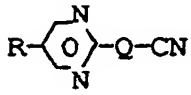
3. Display according to claim 2, characterized in that component A comprises compounds selected from the following group:



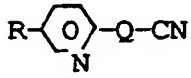
AI



AII



AIII

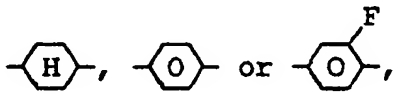


AIV

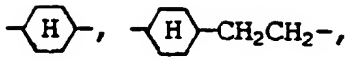
wherein

R is alkyl having 1-12 C atoms, wherein one or two non-adjacent CH_2 groups can also be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O-,

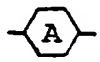
Q is the formula



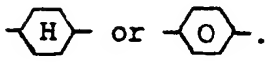
Z^1 is



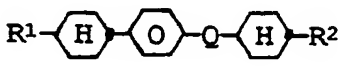
a single bond, $-CH_2CH_2-$, -CO-O- or -O-CO- and



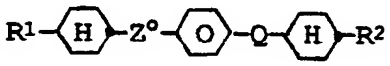
is



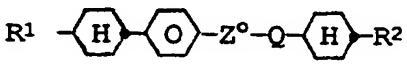
4. Display according to one of claims 1 to 3, characterized in that component B comprises compounds selected from the following group:



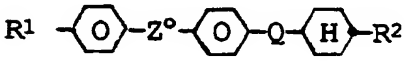
BI



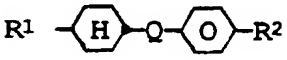
BII



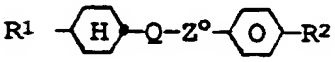
BIII



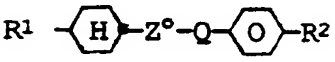
BIV



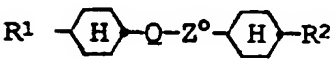
BV



BVI



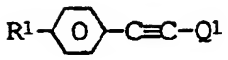
BVII



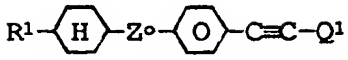
BVIII

wherein R^1 and R^2 each independently of one another are R as defined in claim 3, Z^* is -CO-O-, -O-CO- or $-CH_2CH_2-$, Q is as defined in claim 3 and the 1,4-phenylene ring in BI to BVII may also be substituted in 2- or 3-position by fluorine.

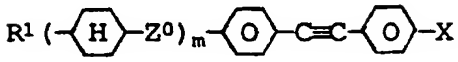
5. Display according to one of claims 1 to 4, characterized in that the liquid crystal mixture contains at least one component selected from group T, comprising compounds of the formulae T1, T2 and T3



T1

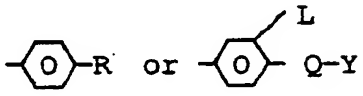


T2



T3

in which Q^1 is



R^1, L, Y and Q are as defined in Claim 1, R is as defined in Claim 3 Z^0 is $-CH_2CH_2-$ or a single bond, X if F or OCF_3, and m is 0 or 1.

6. Display according to at least one of claims 1 to 5, characterized in that the liquid crystal mixture contains one or more compounds wherein R is a trans-alkenyl group or a trans-alkenyloxy group.

7. Liquid crystal mixture of the composition defined in at least one of Claims 1 to 6.

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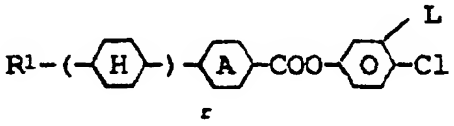
(54) **Supertwist liquid-.crystal display.**

(57) The invention relates to supertwist liquid-crystal displays (SFAs) having extremely short switching times and good steepnesses and angle dependencies, and to the novel nematic liquid-crystal mixtures used therein based on



I

and/or one or more compounds of the formula II

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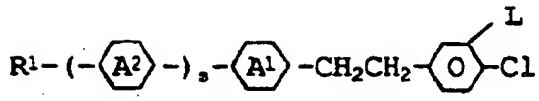
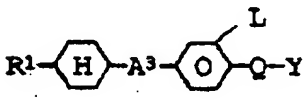


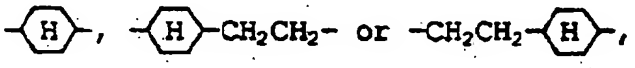
II

and/or one or more compounds of the formula III



III

wherein R^1 is alkyl having 1-12 C atoms, wherein one or two non-adjacent CH_2 groups can also be replaced by -O-, -CH=CH-, -CO-, -O-CO- or -CO-O-, r is O or 1, s is O, 1 or 2, rings A^1 and A^2 are independently from each other trans-1,4-cyclohexylene, 1,4-phenylene or 3-fluoro-1,4-phenylene A^3 denotes



Q is OCFH, OCF_2, CF_2 or a single bond, Y is H, F or Cl, and L denotes H or F.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 10 7939

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y	WO-A-8 908 692 (MERCK) * page 1, line 2 - page 5, line 10 * * page 10, line 11 - line 12 * * page 14, line 7 - line 30; claims 1,5; example 9 * ---	1,4-7 2,3	C09K19/02 C09K19/30 C09K19/42
X	EP-A-0 315 014 (HOFFMANN-LA ROCHE) * page 3, line 2 - line 11 * * page 3, line 30 - line 51 * * page 3, line 55 - page 4, line 5 * * page 5, line 1 - line 15 * * page 5, line 35 * * page 6, line 15 - line 25 * * page 6, line 40 - line 45 * * page 7, line 35 - line 45 * *page 11, line 5, line 29 - line 34* * page 12, line 25 - line 29; example 9 * *Mischung G* * claims 1,5,6,9,10 * ---	1,6,7	
P,X	WO-A-9 102 043 (MERCK) * page 1, line 2 - page 3, line 3 * * page 3, line 25 - page 4, line 2 * * page 8, line 4 - page 9, line 9 * * page 11, line 5 - line 11; claims 1,4-8 * ---	1,5-7	TECHNICAL FIELDS SEARCHED (Int. Cl.5) C09K
P,X	DE-A-4 026 200 (MERCK) * page 2, line 3 - line 12 * * page 4, line 20 - line 35 * * page 5, line 35 * * page 7, line 10 - line 53 * * page 10, line 43 - page 11, line 17 * * page 11, line 41 - line 53 * * page 12, line 28 - page 13, line 15 * * claims 1-7; example 28 * --- -/--	1,4,6,7	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 FEBRUARY 1992	PUETZ C.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
P,X P,Y	EP-A-0 393 443 (MERCK) * claims 1,13-15; example 22 *	1,4-7 2,3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 FEBRUARY 1992	PUETZ C.

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